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ABSTRACT

The purpose of this 233-item annotated bibliography is to present relevant research addressing the primary subskills in the word decoding task. The topical areas of investigation are auditory discrimination, visual discrimination, auditory-visual integration, blending, and cognitive processing of information. An introduction and a cross-referenced subject index are included. (Author)

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Shari Young Kuchenbecker

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COMPONENT SKILLS IN THE WORD DECODING TASK FOR THE BEGINNING READER: AN ANNOTATED CROSS-REFERENCED BIBLIOGRAPHY

Shari Young Kuchenbecker

> Attacking a problem like "how does a child learn to read?" is an interesting challenge to those of us with a bias toward reductionism. Even when the problem is limited to the decoding stage, it is obvious that there are a multitude of task demands--visual and auditory perception, attention, learning, inductive reasonsing, and so on--any of which might easily absorb one for a life time of investigation. (Calfee, Chapman, & Venezky, 1970, p. 1)

While the question of task demands in the word decoding process has recently received the attention of several prominent psychologists and educators, there generally has been a paucity of research which directly addresses this problem. Only a few theoreticians and researchers have ventured to examine the demands and component skills required of the beginning reader.

One of the first psychologists to formulate a schema of skills necessary for the young reader was Eleanor J. Gibson (1969). It was her hypothesis that prerequisite to reading the individual must first learn to speak the language. Second, the individual must learn to visually discriminate and distinguish the letters of the alphabet. Third, the individual must be able to decode the graphic symbols of the language into units of the spoken discourse. And finally, Gibson suggests the last stage of learning to read is the process of reading in higher order units or "chunks" of graphic symbols. This requires the discovery and utilization of the structural regularities and rules of the language in written form. The perfection of this skill may extend over a period of many years.

The Wisconsin Research and Development Center for Cognitive Learning has also taken an interest in the skills required by the beginning reader. One of the projects of the Center has been entitled "Basic Pre-reading Skills." The investigations conducted under this rubric (Venezky & Calfee, 1969) have led to identification of the following basic requirements for learning to read: 1) Entry skills of left-right, top-bottom orientation differentiation; awareness that written symbols translate into spoken words; and the discrimination of letters and words; 2) Aural-oral skills of manipulating separate sounds in words either by reception or production; blending of sounds to form familiar words; connecting words into familiar sequences; 3) Cross-modal correspondence skills of linking letters to their specific sound correlates; discriminating the cues which indicate which of several sounds is to be attached to a given letter; and 4) Processing skills of balancing forward scanning and integration; using stored information to aid in forward search; and searching for reading units larger than letters or single words.

George Marsh (1969) has also advanced postulates regarding the prerequisite skills for the reading process. He suggests that:

> The first stage in the task hierarchy consists of learning multiple discriminations between graphemes and phonemes and the association of each grapheme with its appropriate phoneme. The skills involved can be analyzed into at least four subskills:
>
> a) Identification and differentiation
> b) Production
> c) Generalization
> d) Abstraction. (Marsh, 1969, p. 11)

In the last section of his paper, Marsh proposes the following three areas as prospects for future research: a) phonemic segmentation, b) discrimination and abstraction of graphemes, and c) the organization of letter-sound correspondences and rules to improve their retrieval from memory.

Koehler (1970) has addressed the question of reading skills more narrowly by identifying only the components of the word decoding process. He says:

> Word decoding consists of the following processing skills:
>
> 1) abstracting or visually isolating letter and letter sequences from the word context,
> 2) retrieving the coded sound correspondents of the isolated word elements,
> 3) sequencing the sound correspondents to match the words spelling pattern, and
> 4) synthesizing or amalgamating the sound correspondents to form the pronunciation contour for the word.
>
> The order of listing the skills should not convey that decoding necessarily proceeds in the same serial order. Skills (1), (2), and (3) would occur concurrently when the sound correspondent for each element is retrieved as the elements are identified in a left-to-right sequence during word scanning. It is further possible that the synthesizing of sound correspondents can begin after at least two sounds have been retrieved. (Koehler, 1970, p. 4).

As the reader may observe, all four of the theoretical schemas of subskills in word decoding presented here seem to have similar interpretations of the reading task requirements. For example, all four mention visual discrimination as a necessary component for beginning reading. Further, all allude to some cognitive or conceptual processing skills as mandatory to the task. Three of the four schemas specifically mention auditory skills as prerequisite and two of the four regard blending as necessary. We may summarize, therefore, that while the research directly addressing the problem of component skills is sparse, there is a moderate consensus among those investigating the problem as to the constituent task demands.

It would be beyond the scope of the purpose here to examine in detail each of the specific component skills suggested by the various individual researchers. Instead, the purpose is to present a select review of the literature relevant to the word decoding task. It has been the author's aim to present only those studies which appear to be generally free of methodological problems which could have influenced the interpretation of findings. Where such experimental design problems appear to be present and yet the findings still are of interest, this has been noted for the reader. Further, an attempt has been made to use primarily research investigations which employed children in the three to seven year age range as subjects. Where the research was not available with this young group, but the implications from the population employed were quite clear and especially relevant to our purpose, such studies were included.

The paper is divided into five major sections, each specifically handling a different subskill area. The sections are entitled:

1) Visual Discrimination
2) Auditory Discrimination
3) Auditory-Visual Integration
4) Blending
5) Cognitive Processing

As one might expect, some of the individual research studies address or touch upon more than one of the major subskill areas. To assist the reader, duplicate entries of such studies have been included in the appropriate sections. Additionally, a cross-reference index immediately follows the References and includes a listing of major and minor topics pertainent to an overview of the word decoding task.

The format of presentation is an annotated bibliography. Generally, the author's abstract has been chosen to represent the findings of the research. When, however, the author's abstract did not sufficiently explicate the research findings as pertinent to our work, additional quotes from the article have been added or further abstraction of the article has been made. The latter abstracts are indicated by an asterisk at the end of each article.

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AUDITORY-DISCRIMINATION

1. Bruce, D. J. The analysis of word sounds by young children. *British Journal of Educational Psychology*, 1964, 34, 158-170.

   This study is concerned with the development of the ability to make a simple phonetic analysis of the spoken word. It describes the performance of children at different levels of mental development on the task of analyzing word sounds into two components: a letter sound and a sound unit which is the residual word obtained by elision of the letter sound from the test word.

   The results, which refer to the mental age of 5+ to 9+, suggest that there is a gradual progression towards accurate phonetic analysis, in the course which children: a) come to recognize that words and sounds are interrelated, b) acquire criteria of what constitutes analysis, c) achieve positional differentiation, d) overcome the cohesiveness of the word sound pattern in their experience.

   These necessary features of the ability are not attainable in discrete, successive steps, but are present in increasing proportions with advancing mental age. Mental age of 7+ is indicated as the level at which they first become available in sufficient degree to permit some success with the task.

2. Bugarella, R., & Archer, E. J. Concept identification of auditory stimuli as a function of amount of relevant and irrelevant information. *Journal of Experimental Psychology*, 1962, 63, 254-257.

   The effect upon concept identification of the simultaneous variation of nonredundant relevant and irrelevant auditory information was determined. The design had three levels (1, 2, or 3 bits) of relevant information orthogonal to three levels (0, 1, or 2 bits) of irrelevant information. There were five different problems within each of the three levels of relevant information. Two subjects were assigned to each of the 45 combinations of problems and information.

   The subject's task was to place auditory stimuli into one of two categories, i.e., distinguish between positive and negative instances of conjunctive concepts. Ninety subjects served individually to a criterion of 32 consecutively correct responses or a maximum of 192 trials (whichever occurred first). The subjects received immediate information feedback about the correctness of their responses through two signal lights.

   The major results were: (a) Performance, as measured by trials, errors, and time to criterion, degraded as a linear function of both nonredundant relevant and irrelevant information. (b) The interaction between the two variables of relevant and irrelevant information was not significant.

3. Calfee, R. C., Chapman, R., & Venezky, R. L. How a child needs to think to learn to read. In Gregg, L. (Ed.), *Cognition in learning and memory*. New York: John Wiley & Sons, 1969.

This report summarizes 1968-1969 studies of component pre-reading skills of kindergarteners. Working from the assumption that independent component skills might exist, four skill areas were selected for investigation on the basis of literature findings and a decoding model of reading: visual, acoustic-phonetic, letter-sound association, and vocabulary skills. A research strategy is presented for the development and validation of assessment tests in each area and the subsequent development and validation of training procedures. The research reported here is concerned with skill assessment in each of the areas.

The four skill areas were investigated through the use of experimental Basic Skill Test batteries administered individually to kindergarteners from a lower-middle class population in Madison (N = 21) and a lower-class population in Beloit (N = 22). Madison subjects participated in three 30- to 50-minute sessions in November, December, and January; Beloit subjects in one 45-minute session in March.

Methods, results, and discussion are presented in detail for each of the four skill areas and invalid test procedures identified (e.g., same-different tests of rhyming). In the remaining tests, errors are examined for sources of difficulty (e.g., left-right letter reversals) and the pattern of interest correlations examined. The findings support an assumption of independent skills related to reading.

Even though the BST package is in a preliminary form, and despite the limited number of subjects, certain conclusions are worth noting. First, if skill components are narrowly defined, they appear remarkably independent. This independence is not the result of suppressing variation among individuals: from the bimodal distribution of subjects in Rhyme-Production one might well expect high correlation with other tasks, and yet these are not found except for the segmentation test.

With regard to specific skill areas, it appears that visual perception skills contribute only minimally to matching tests. Few errors are made in the matching of single letters, where perceptual problems should play the primary role. Instead, the problems which arise seem to be of a cognitive nature, such as order and memory for forms. The data suggest that sound matching, segmentation, and association of sounds and symbols are poorly developed skills in most kindergartners. However, testing procedures may be at fault--a possibility which must be evaluated more fully.

Finally, two comments can be made about the relation of the BST data to reading achievement. First, correlational data on this relationship will be available in a year and the relation can be determined empirically. Second, inquiries about the relation of specific component skills to reading achievement may be irrelevant to our purpose because most achievement tests are not particularly sensitive to the decoding process on which BST package focuses.

4. Calfee, R. C., & Venezky, R. L. Component skills in beginning reading. In Goodman, K. S., & Fleming, J. T. (Eds.), *Psycholinguistics and the teaching of reading*. Newark, Delaware: IRA, 1969.

Calfee and Venezky present a review of popular Reading Readiness Tests including the Metropolitan Readiness Test (METRO), Doren Diagnostic Reading Test, Pintner-Cunningham Primary Test (P-C, 1946), and Murphy-Durrell Reading Readiness Analysis (M-D) and finally, the MacMillan Reading Readiness Test. Calfee and Venezky further reviewed the subtests in each of the Reading Readiness Tests and concluded that intercorrelations between and within tests were relatively high. (METRO Listening and Thurstone-Jeffrey Identical Forms Tests excepted). Further, all the tests showed a high correlation with performance on the Stanford Achievement. The P-C intelligence test correlated to the same extent with all of the readiness and achievement subtests. The indication was that 1) the ability to identify alphabet letters at the end of the first grade and reading achievement are closely related; and 2) 80% of the Stanford Tests yield similar achievement scores.*

In conclusion, the authors state "like others, the writers would like to find more effective ways to teach reading. It seems futile to introduce more new methods until necessary insights into the nature of the reading process are established by appropriate research. Dissection of the process into its components is an impossible venture when each measure correlates with every other measure to the same extent--hence, the concern with testing procedures. The writers are optimistic about the possibility of finding reliable instruments sensitive to well-defined skills and would be quite pleased to find that tests of articulation and discrimination ability were only slightly correlated with one another and that neither was significantly related to performance on current readiness or achievement tests. After all, it is hard to believe that the sum total of a child's intellectual ability can be measured by his knowledge of letters of the alphabet prior to first grade."

5. Cavoures, D. G. Phoneme identification in primary reading and spelling. Unpublished doctoral dissertation, Boston University, 1964.

Cavoures gives evidence that children have more difficulty recognizing phonemes that are in a terminal or a medial position as compared to recognition ease with phonemes in an initial position.*

6. Chall, J. *Learning to read: The great debate*. New York: McGraw-Hill, 1967.

Chall gives a review of the literature and concludes from her findings that the ability to hear individual sounds in words (i.e., phonetic segmentation) is a very important skill prerequisite to learning to decode a word. Further, Chall asserts that this ability provides one of the best predictors of success in beginning reading.*

7. Desberg, P. Blending: preliminary analysis and literature review. Research Memorandum, June 5, 1969, Southwest Regional Laboratory, Inglewood, California.

In the act of reading, one does not proceed directly from print to meaning. There is an intermediate stage in which a set of decoding skills is used to enable the reader to identify his spoken words in printed form. The initial stages of reading instruction are concerned primarily with the student's acquisition of these word identification skills. However, as instruction progresses the emphasis is transferred to comprehension skills. ...The identification phase of reading has been represented as a series of four chronologically related stages (Desberg & Berdiansky, 1968): Discrimination, Blending, Phonics Rules, and Residual. The first stage of this conceptualization involves discrimination learning. This is the visual and auditory differentiation of letters, and ultimately results in the association of letter-sound correspondences. Blending, the subject of this paper, is the production of a word or syllable through synthesis of its component sound (this definition is introductory and will be explained later in the paper). Phonics rules refer to a set of higher-order correspondence rules that describe, more thoroughly, the relationship of English orthography to English pronunciation. The residual stage refers to the instruction of low frequency phonics rules, regular but complex rules (e.g., morpho-phonemic shifts, etc.), and idiosyncratic rules.

8. Desberg, P. Sound blending: The relationship of inter-letter interval, consonant category, and stimulus word frequency to word identification. Unpublished doctoral dissertation, University of Southern California, 1969.

Sixty subjects were randomly divided into four groups, on the basis of stimulus words received: high frequency stops (group 1), low frequency stops (group 2), high frequency continuants (group 3), and low frequency continuants (group 4). Each subject received the stimulus word separated at five inter-letter intervals (0, 0.5, 1.0, 1.5, and 2.0 sec.).

Consonant category referred to a division based upon initial consonants. The following consonants were designed as stops: /p t k b d g č ǰ/. The continuant consonants were: /f v s z s m n l r θ w/. Stimulus words were also divided into two frequency levels (high and low) based upon the G count of the Thorndike-Lorge word count. Each stimulus word was recorded on an individual tape loop at each inter-letter interval.

Significant differences in the number of correct word identification were attributable to the factor of inter-letter interval length. These differences were only found in compairsons involving the 0.0 second group. When this level was deleted, the data were re-analyzed, there were no differences attributable to inter-letter interval length. Based upon these results, stage 2 was deleted from the model.

Words beginning with stop consonants were identified correctly more often than words beginning with continuant consonants. There was no significant interactions between consonant category and inter-letter interval. An experiment designed to investigate the relative importance of consonant category to blending and word identification was proposed.

High frequency stimulus words were identified correctly more often than low frequency words, however, interactions predicted between stimulus word frequency and the other two factors were not found.

9. Dolch, E. W., & Bloomster, M. Phonic readiness. *Elementary School Journal*, 1937, 38, 201-205.

Undertaking a study of 58 first grade and 57 second grade pupils on mental age and phonic ability, Dolch and Bloomster concluded from their investigations that children below a mental age of 7 years are unable to perform and master the task of phonemic segmentation. Further, they found that mental age and phonic achievement were significantly correlated (r = .4 to .5). Despite this fact, they also noted that children with high mental ages do not necessarily possess advanced phonic skills.*

10. Durrell, D. D., & Murphy, H. The auditory discrimination factor in reading readiness. *Education*, 1953, 73, 556-560.

Durrell and Murphy attempted to examine the relationship of reading achievement in grades one, two, and three and the ability to identify sounds in spoken words. Correlations between the auditory analysis ability and reading achievement were found to be .56, .52, and .52, respectively. Based on their research results and other literature on the topic, the authors concluded that the ability to perform an auditory analysis of words spoken was a highly important factor in determining a child's success in learning to read. Despite this strong assertion, Durrell and Murphy further noted that a high mental age does not assure that the individual possesses auditory analysis abilities.*

11. Dykstra, R. Auditory discrimination ability and beginning reading achievement. *Reading Research Quarterly*, 1966, 3, 5-34.

This reports relationships between prereading measures of auditory discrimination and reading achievement at the end of first grade. Seven measures of auditory discrimination and a group intelligence test were administered at the beginning of first grade, and two measures of reading achievement were given at the end of first grade. Complete data were gathered on 632 pupils. Relationships were assessed by means of correlation analysis and multiple regression. Results showed intercorrelations among auditory discrimination measures and between each measure and subsequent reading achievement to be uniformly low with few reaching .40. Five of the seven auditory discrimination measures made a significant contribution to a multiple regression equation which was designed to predict reading achievement. In addition, intelligence was significantly related to reading achievement. Nevertheless, variation in performance on the auditory discrimination and intelligence measures accounted for less than half of the variation in performance on the reading measures. Other findings included significant sex differences in performance on three of the auditory discrimination tests and on both reading tests. All such differences favored girls.

Surveying the relationship between auditory discrimination skills and reading achievement by simultaneously measuring the two leads to different conclusions depending on the population studied. When the auditory discrimination abilities of disabled readers are examined, the research is in general agreement that disabled readers are markedly deficient in these skills. However, examining relationships between auditory discrimination and reading achievement of unselected populations of elementary and secondary pupils results in inconclusive findings. Investigators using similar techniques report very different results ranging from substantial correlation relationships to no relationship at all. Furthermore, age does not seem to be a factor in determining whether or not skill in auditory discrimination is related to reading achievement. Studies involving pupils from grades two through twelve appear to be equally inconclusive in trying to establish the extent of these relationships.

Studies which have attempted to assess the relation of auditory discrimination ability during the prereading period to future success in learning to read have generally reported small positive correlational relationships ranging from approximately .20 to .41.

12. Elkonin, D. D. The psychology of mastering the elements of reading. In Simon, B. (Ed.), *Educational psychology in the USSR.* Stanford, Stanford University Press, 1963. Pp. 165-179.

In teaching children five and six years old the main fact that we came up against is that they do not know the sounds of language, do not hear and are unable to distinguish the separate sounds within a word. The formation of this action is therefore difficult.

13. Gates, A. I., Bond, G. L., & Russell, D. H. *Methods of determining reading readiness.* New York: Teachers College, Columbia University, 1939.

In a research study beginning in 1934, Gates, Bond, and Russell investigated a multitude of methods of appraising reading readiness, including a number of auditory discrimination tasks. They computed the correlations between each of the auditory tasks and reading achievement measured in a number of ways. The population was four New York City public shool first-grade classes and the measures were compiled three times: mid-first-grade; end of first-grade; and mid-second-grade. The mean correlation coefficients were computed to give some indication of the relationship between each auditory instrument and general reading ability. The average correlations they obtained were:

1. giving words with the same or rhyming final sounds .43.
2. giving words with stated initial sounds -.41.
   (score was the number of errors)
3. blending .38.
4. reproduction of nonsense words .23.
5. giving letters for sounds .21.
6. discriminating word-pairs .20.*

14. Gibson, E. J. *Principles of perceptual learning and development.* New York: Meredith Corporation, 1969.

An analysis of how reading skill is acquired leads us to recognize that there are several subskills and that certain subskills are logical prerequisites for others. First comes the skill of learning to speak the language. The child has been learning this for six years before coming to school, and will continue to perfect his language skills for many years. But fairly expert perception of speech is essential before it is feasible to begin learning to decode another symbol system to it. It is not enough to comprehend the meaning of a spoken message; the child must be able to perceive its segmentation and combinatory order.

15. Gilbert, C. J., & Niedermeyer, F. C. Effects of auditory discrimination training on articulation of /th/-deficient primary-grade children. Technical Memorandum No. TM-3-71-04, 1971, Southwest Regional Laboratory, Inglewood, California.

This experiment examined the effects of auditory discrimination training on the articulation performance of /th/-deficient primary-grade children. Two matched groups of 28 subjects each received individualized speech instruction from trained paraprofessionals employing either articulation plus auditory discrimination training (A+D) or articulation only training (AO) on a 25-minute per day basis for approximately five weeks. The instruction brought the auditory discrimination performance of A + D subjects up to the level of normal-speaking children, but the /th/ articulation posttest performance of A + D subjects was no different from that of the AO subjects.

16. Harrington, M. J., & Durrell, D. Mental maturity versus perception abilities in primary reading. *Journal of Educational Psychology*, 1955, 46, 375-380.

Harrington and Durrell surveyed approximately five hundered parochial school second-grade pupils in Boston. Auditory discrimination abilities were examined through tests including rhyming at the ends of words, final consonants, the ability to notice initial consonants and their sounds, and a combination of initial and final consonants in words spoken by the examiner. The pupils were matched with respect to mental age, visual discrimination, and phonic ability. Concurrently, each matched pair differed widely in auditory discrimination skill. This made it possible to compare the reading ability of children with high and low auditory discrimination. The results yielded were highly significant and indicated that the pupils with superior auditory and visual discrimination were also superior in reading ability. The auditory discrimination results were later replicated with a thousand second-graders in Oklahoma and Kansas.*

17. Heilman, A. W. *Principles and practices of teaching reading.* Columbus Ohio: Charles E. Merrill, 1967.

Heilman gives evidence that the position of the phoneme is an important variable in phonemic segmentation. He asserts that recognition of medial vowel sounds will be more difficult than the recognition of consonants in the initial and terminal positions.*

18. Holland, A., & Matthews, J. Application of teaching machine concepts to speech pathology and audiology. In Sloane, H. N., & MacAuley, B. D. (Eds.), *Operant proceedings in remedial speech and language training.* Boston: Houghton Mifflin, 1968.

Holland and Matthews have reported that their studies indicate that subjects who spontaneously vocalize during a speech discrimination task seem to perform better than those who do not engage in this behavior.*

19. Huttenlocher, J. Children's language: Word-phrase relationships. *Science*, 1964, 143, 264-265.

It has generally been assumed that children of 4 or 5 years of age who speak fluently can differentiate single words from multiple word utterances. The demonstration that children have a tendency to define a single unknown word in terms of the entire context in which it occurs suggests, however, that each word is not endowed with a distinct meaning.

Sixty-six children between the ages of 4 1/2 and 5 were used as subjects. The experiment here was designed to determine if there is difficulty for the preschool child to divide common word sequences into separate words. Pairs of digits were read to children and they were taught to say them in reverse order. This skill, easily acquired by most children between 4 and 5 years of age, could be transferred to pairs of letters and pairs of nouns. But when commonly encountered "grammatical pairs" for example, (he went or pretty doll) were presented, these children had great difficulty in reversing them.

To summarize, small children who could reverse the order of certain two-unit utterances had difficulty reversing utterances that formed common English sequences. Findings of this study indicate that the following factors are sources of difficulty in reversing pairs: a) inability to separate English sequences into word units, and b) semantic absurdity of reversed pairs.

20. Koehler, J., Jr., Bennett, R., & Mineo, R. J. The effects of letter pattern training and grammatical context on sight word learning in kindergarteners. Technical Note No. TN-2-71-17, 1971, Southwest Regional Laboratory, Inglewood, California.

Eight groups of kindergarten subjects were trained to discriminate position and order differences in verbal and nonverbal item sequences in the context of a matching task or an associative learning task or both. Transfer was measured by having the subjects sight learn a list of words contrasting in position and order. Subsequently, new function and content words were learned in a sentence format and all previously learned words were given additional practice in sentences.

There was little indication that item sequence training improved sight word learning. Grammatical context failed to assist function words learning and showed some impairment of content word learning. While additional sentence practice showed significant improvement in word learning, substantial word recall errors following practice suggested that sentence practice was an inefficient way to learn words.

In consequence of these results, it was suggested that subsequent studies consider whether acoustic recognition accompanying the letter differences would improve word learning and that the list format be used for learning sight words prior to sentence reading.

21. Marsh, G. Conceptual skills in beginning reading. Technical Report No. 18, July 16, 1969, Southwest Regional Laboratory, Inglewood, California.

This paper presents a task analysis of the conceptual skills prerequisite to learning to read by a phonics-based method. An attempt is made to distinguish these skills from reading's component skills. Basic to this paper is the assumption that analysis of the prerequisite skills is a necessary preliminary to understanding the reading process. Topics discussed include discrimination and abstraction of graphemes, phonemic segmentation, organization and memory, multiple discrimination and association, concept of class, information reduction, sequential rules, logical rules, inductive and deductive techniques, and organized access and use of memory.

It is generally agreed that an important prerequisite skill involved in learning to read is the ability to distinguish the separate sounds in words. The approach taken in the present paper would suggest that the inability to perform phonemic segmentation tasks may lie in the lack of training in prerequisite skills, rather than in insufficient maturation. The research literature on phonemic segmentation is somewhat sparse and scattered. Phonemic discrimination is a skill prerequisite to phonemic segmentation.

22. Marsh, G., & Mineo, J. Children's recognition of phonemes in a word context. Technical Note No. TN-2-70-46, 1970, Southwest Regional Laboratory, Inglewood, California.

Sixty-four preschool children were trained on a task requiring them to recognize an isolated phoneme in a word context. A learning set design encompassing 192 trials over eight days was employed. Five relevant factors were investigated: a) the presence of a redundant visual cue; b) the type of phoneme (stop vs. continuant); c) the phoneme position; d) the phonemic contrast between the positive and negative exemplars.

The redundant visual cue improved performance considerably but performance fell to control group levels in the second week when the cue was removed. Generally, continuants were superior to stops. The position and contrast factors interacted with phoneme type. Groups transferred within phoneme class were superior to those transferred between phoneme class. In the second week a number of variables interacted in a complex fashion.

23. Marsh, G., & Sherman, M. Kindergarten children's discrimination and production of phonemes in isolation and in words. Technical Memorandum No. TM-2-71-07, 1971, Southwest Regional Laboratory, Inglewood, California.

Fifty kindergarten children's ability to discriminate and produce the phonemes typically used in early phonics-based reading instruction was investigated in an AB-X discrimination task and an echoic production task. The phonemes were presented in isolation and in a word context in both tasks to each child.

It was found that (1) more discrimination than production errors were made, a difference which was reliable only for the vowels, (2) vowels were easier to discriminate and produce than consonants, and (3) phonemic errors were fewer in words than in isolation, a difference which reached significance only in the production data. Most importantly, further data analysis revealed that frequency of a phoneme in the conversational speech of kindergarteners and in the lexicon of the Southwest Regional

Laboratory First Year Communication Skills Program did not predict articulation difficulty of a phoneme either in words or in isolation.

The research literature on phonemic segmentation is somewhat sparse and scattered. Phonemic discrimination is a skill prerequisite to phonemic segmentation.

24. Miller, G. A. Decision units in the perception of speech. *IRE Transactions on Information Theory*, 1962, IT-8, 81-83.

Miller states that an individual is capable of about one decision per second when processing speech. When, however, listening to normal speech at 150 words per minute, a listener is required to make 100 phonetic decisions per second if he is decoding on the phonetic level. The implication of this information for teaching reading with a phonics approach is clear. Individuals do not normally listen to speech on a phonemic level, but rather decode using larger units of auditory input than singular phonemes. When we begin instruction in a phonics program, we ask the child to attend to tiny discrete units (phonemes) in a flow of speech. These are such small segments that the child probably has had little commerce with decoding on this level since infancy.*

25. Mulder, R. L., & Curtin, J. T. Vocal phonic ability and silent-reading achievement: A first report. *Elementary School Journal*, 1955, 56, 121-123.

From this study it may be concluded that (1) poor readers are deficient in the ability to synthesize phonetic elements of words into meaningful word patterns. This deficiency may be attributable to lack of training in auditory discrimination or to lack of training in phonics. (2) Good readers apparently possess the ability to synthesize phonetic elements into words to a marked degree. Since both auditory discrimination and proficiency in phonics is characteristic of good readers, success on the vocal phonics test might be directly related to these skills.

Still in need of study are the following related problems:

1. The relation of general intelligence to the ability to synthesize phonetic elements into words.

2. The effect on reading ability of a systematic training program in blending sound elements into words.
3. The determination of words which, by their nature, present persistent and frequent difficulty in oral synthesization, for example, *wear* and *where*.

Subsequent investigation could profitably deal with these areas in order to delineate further the problem under study in this report.

26. Murphy, H. A. Auditory discrimination in reading. Unpublished doctoral dissertation, Boston University, 1943.

Murphy performed a very early study on the effects of giving phonetic segmentation and auditory discrimination training to new readers. Results showed that the group given the training was superior on global performance on reading achievement tests.*

27. McNeil, J. D., & Coleman, J. C. Auditory discrimination training in the development of word analysis skills. USOE Project No. 5-0503, 1967, University of California at Los Angeles.

This is a report of an experimental study designed to test the hypotheses that children who are taught to hear and designate separate sounds in spoken words will achieve greater success in learning skills associated with the task of analyzing printed words. The study also sought to answer questions regarding the characteristics of learners who can benefit most from such training, how best to facilitate auditory discrimination, and how generalizable is auditory training that leads to recognition of specific sounds and their position in the spoken word.

The subjects of the study were 90 kindergarten children, predominately Mexican-American and Negro, living in a low socioeconomic area. These children were randomly assigned to one of three treatments. Each treatment was of three weeks duration and included (1) an auditory training program which was completely auditory, no visual stimuli, (2) a reading program which contained both visual and auditory stimuli, and (3) a non-instructional control group. All programs were presented by auto-instruction. The children received their instructions via taped commentary. Following the experimental treatments, children from the three groups received instruction from an automated program in reading.

Relative achievement on the reading program was shown by reading error rate scores earned on a word analysis test and on scores earned on an auditory discrimination test administered after the programmed reading lessons.

The results showed that those who had been taught to hear and designate separate sounds in spoken words achieved greater success on tasks associated with analysis of printed words and that auditory training contributed to lower errors during instruction in reading. It was demonstrated that an exclusively auditory program followed by reading was more effective than taking the reading program once or twice without auditory training. Boys and children of lower intelligence profited most from auditory training. Such training helped the Mexican-American in ways different from the ways it helped Negroes. The Negroes gained in a greater range of word analysis skills as a consequence of auditory training. The identification of final phonemes in spoken words appeared to be of more value to speakers of Negro dialect.

Auditory training on selected phonemes contributed to the learner's future success in learning to associate graphemes and phonemes even when the phonemes were not those used in auditory training. Although auditory discrimination increased incidentally during instruction in reading, the evidence suggests that it may be accelerated by a supplementary program which does not employ visual stimuli.

28. McNeil, J. D., & Stone, J. Note on teaching children to hear separate sounds in spoken words. *Journal of Educational Psychology*, 1965, 56, 13-15.

To test the hypothesis that children learn to identify sounds in spoken words better through practice with nonsense then with familiar words, 60 kindergarten children, divided into two matched groups, were individually taught by self-instructional materials. One group received training that required responding to the sounds as they appeared in nonsense terms, the other to sounds as they appeared in meaningful terms. Children trained with nonsense words made fewer errors during the training period and on the criterion test did significantly better in identifying sounds found in both nonsense and meaningful words ($p < .01$).

29. Poling, D. L. Auditory deficiencies of poor readers. *Clinical Studies in Reading II, Supplementary Educational Monographs*, 1953, 77, 107-111.

Poling did an investigation with reading disability cases at the University of Chicago Reading Clinic between the years of 1944 and 1949. He obtained his data from a population of 58 boys and 20 girls between the ages of 8 and 13 with intelligence quotients

Experiment II differed from Experiment I only in that it involved fricatives instead of stops. The six fricatives /f/, /v/, /θ/, /ð/, /s/, /z/ were employed in making up the nine contrasts.

The results for Experiment I showed that subjects discriminated the stops significantly better in long vowel contexts than in short vowel contexts. The discrimination rates for each contrast, collapsed over all vowels, did not differ from one another.

For Experiment II, the results indicated that discriminations of place contrasts involving /s/ or /z/ as well as the homorganic voicing contrasts were not subject to differential vowel effects. Discrimination of /f/ from /θ/ and /v/ from /ð/, however, were significantly better in back vowel contexts than in front vowel contexts. Discriminations of /f/ from /θ/ and /v/ from /ð/ were found to be significanlty more difficult than the discriminations of the other fricative contrasts.

The results show that effects of coarticulation do affect discrimination probabilities. These findings call into question theories that propose any one-to-one correspondence between the acoustic segment and the sound perceived.

34. Rudegeair, R. E., & Kamil, M. L. Assessment of phonological discrimination in children. Technical Report No. 118, March, 1970, Wisconsin Research and Development Center for Cognitive Learning, Madison, Wisconsin.

A review of the literature led the present investigators to conclude that conventional tests are inadequate for accurate assessment of phonological discrimination ability in children. Higher error rates on discrimination tests than those which would be predicted from articulation measures seem to implicate task variables. To reduce task difficulty, the present investigators developed repeated contrast test pairs. Such pairs consist of CVC syllables in which the same phonemic contrast occurs twice (e.g., /bob/ - /dod/). Multiple-testing sessions were also employed to reduce initial task difficulty.

Two experiments were conducted to determine the effects of task variables. In Experiment I, nonsense syllables were used in an A-B-X paradigm. Subjects were twelve first grade and twelve kindergarten children. Mixed lists of repeated contrasts, initial contrasts, and final contrasts pairs were tape recorded and presented to each subject, one list per day for six days.

Experiment II involved using the real word items from the Wepman Test of Auditory Discrimination. Subjects were the twelve first grade subjects from Experiment I and twelve additional first grade subjects. Testing was conducted following the instructions for administration of the test. Four testing sessions were given each subject.

The results for Experiment I showed that repeated contrast pairs were easier to discriminate than either initial or final contrast pairs and that there was no difference between initial and final contrast pairs. Performance on Day 1 was significantly poorer than on all other days, and there was no difference among the other five days.

For Experiment II, performance on Day 1 was also significantly poorer than on the other days. In addition, it was found that there was no difference in performance for "new" and "old" subjects.

The results have two major implications: First, repeated testing is a necessity for young children. Second, repeated contrast pairs may provide a means of obtaining a more complete assessment of phonological discrimination ability in children.

35. Schonell, F. J. *Backwardness in the basic subjects*. Edinburgy: Oliver & Boyd, 1948.

In a review of the topic of backward readers, Schonell states that over a period of eight years, over 38% of the children with reading difficulty demonstrated some degree of deficiency in auditory discrimination of speech sounds. Further, Schonell suggested that a weakness in auditory discrimination abilities was one of the largest contributing to reading disability.*

36. Shankweiler, D., & Studdert-Kennedy, M. Identification of consonants and vowels presented to left and right ears. *Quarterly Journal of Experimental Psychology*, 1967, 19(1), 59-63.

The results of earlier studies by several authors suggest that speech and nonspeech auditory patterns are processed primarily in different places in the brain and perhaps by different modes. The question arises in studies of speech perception whether all phonetic elements or all features of phonetic elements are processed in the same way. The technique of dichotic presentation was used to examine this question.

The present study compared identifications of dichotically presented pairs of synthetic CV syllables and pairs of steady-state vowels. The results show a significant right-ear advantage for CV syllables but not for steady-state vowels. Evidence for analysis by feature in the perception of consonants is discussed.

37. Skeel, M. H., Calfee, R. C., & Venezky, R. L. Perceptual confusions among fricatives in preschool children. Technical Report No. 73, February, 1969, Wisconsin Research and Development Center for Cognitive Learning, Madison, Wisconsin.

This study examined perceptual and articulatory confusions among the fricatives /f, v, s, z, θ, ð/ in preschool children. These phonemes were selected because they are among the most difficult for the children to articulate. Seventeen children between 3.3 and 5.1 years old were tested on syllables formed by taking all combinations of the six fricatives in initial (CV) and final (VC) positions with one of the vowels /a, i, aɪ/. Discrimination and articulation tests of this syllable set were then administered. An audiovisual system was used to test discrimination by the following procedure. The child heard a syllable (e.g., "/fa/") over earphones, and simultaneously saw a brightly colored animal drawing on the left side of the visual display. Next, a second syllable (e.g., "/va/" was heard, and a second animal appeared to the right of the display. Then both animals were shown and the child was asked to identify one of the syllables, (e.g., "Who said /va/") by pressing a glass panel over the appropriate animal. Each fricative pair differed only in the fricative phoneme (e.g., /fa-va/), vowel and position being identical. Control pairs differing on several phonetic features were interspersed throughout the test series (e.g., /ao-ki/). In the articulation test, the child repeated each syllable after experimenter.

The fricatives were substantially more difficult to discriminate than the control items (error rates of 28% and 13% respectively). Two contrasts, /v-ð/ and /f-θ/, were particularly difficult. There were fewer errors on VC than CV pairs. No differences were associated with the vowel, but there was some evidence that vowel duration was employed as a cue for discrimination of fricatives in final position. While there was a significant correlation between the number of discrimination and articulation errors per child, there was little evidence that articulation errors on specific phonemes were accompanied by discrimination errors on the same phonemes. Discrimination and articulation errors both resembled the patterns of errors found in tests of phoneme perception in adults. There was no evidence that the frequency of occurrence of specific phonemes in children's speech was substantially related to discrimination or articulation.

38. Steinbach, M. N. An experimental study of progress in first grade reading. *The Catholic University of America Educational Research Monographs*, 1940, 12, 1-118.

Using a sample of three hundred entering first grade children who had been given a large array of reading readiness tests, and specifically one test of auditory discrimination (word pairs discrimination), Steinbach compared each test with reading achievement. She found that the word pairs discrimination test ranked second in terms of its relationship with reading achievement at the end of first grade. Further, she found that the word pairs auditory discrimination test ranked first with respect to its contribution to a multiple regression equation in the predictive capacity for mid-year and end of year reading achievement.*

39. Templin, M. C. A study of sound discrimination ability of elementary school pupils. *Journal of Speech and Hearing Disorders*, 1943, 8, 127-132.

This study of the sound discrimination ability of elementary school children (grades 2-6) was conducted with two ends in view. The first purpose was to determine with two 100 item tests whether there was any variation in the ability of the children to discriminate between identical and unlike syllables when the position of the descriptive element was changed from the initial to the medial or final positions. The second objective was to detetermine whether a short test of sound discrimination could be used satisfactorily.

The results of the study on sound discrimination ability indicates:

1. That there is a real difference in the scores made on a sound discrimination test when the discriminate element is changed from the initial to the medial or final position. The children in all grades made more errors when the consonant or combination was in the medial or final position. In the second grade the results obtained with respect to this positional effect could have been obtained by chance 24% of the time; in all other grades, and for the group as a whole, they could have been obtained by chance less than 1% of the time.

2. That a relatively short test of sound discrimination can be effectively used. The correlation ratio for the prediction of the score on the short test of 70 items from that on the combined test of 200 items is .922.

40. Thompson, B. B. A longitudinal study of auditory discrimination. *Journal of Educational Research*, 1963, 56, 376-378.

Thompson looked at a population of second grade readers and separated them into two groups. There were twenty-four children classified as the best readers and twenty-four children classified as the poorest readers. Of the best readers, Thompson found that sixteen of them had displayed adequate auditory discrimination abilities when tested upon entrance to the first grade. On the other hand, of the twenty-four poorest readers, only one child had shown adequate auditory discrimination abilities at the first grade testing. Both good and poor readers made gains in auditory discrimination abilities, but the poor readers made greater proportionate gains than good readers. She concluded from the statistical analysis of the data that both auditory discrimination and intelligence are highly correlated with success in primary reading.*

41. Venezky, R. L., Calfee, R. C., & Chapman, R. S. Skills required for learning to read: A preliminary analysis. Progress report, undated, Wisconsin Research and Development Center for Cognitive Learning, Madison, Wisconsin.

Venezky, Calfee, and Chapman point out that the task of auditory discrimination is a complex process requiring several skills to be performed correctly. For example, if a child is given an array of words spoken by the teacher which begin with the same sound (consonant phoneme) and is then required to select from a list of other items those which have the same sound as the original list, his task includes: a) being able to distinguish initial, medial, and terminal positions in the item uttered; b) abstraction of the individual sounds; c) understanding of the concepts of same and different; d) memory capacity capable of retention of the exemplars; and e) capacity to compare and contrast the speech sounds.*

42. Wheeler, L. R., & Wheeler, V. D. A study of the relationship of auditory discrimination to silent reading abilities. *Journal of Educational Research*, 1954, 48, 103-113.

Employing an unselected population of 629 children from fourth, fifth, and sixth grade classes, Wheeler and Wheeler measured auditory discrimination abilities in a number of ways. The tests included such tasks as having each subject 1) discriminate typical word pairs, 2) discriminate between paired sounded elements and determine whether each pair was the same or different (er-or; er-er, etc.), 3) select the nonrhyming word from an array of four, and 4) having heard a word pronounced by the examiner, pick from an array of three sounds that sound which was heard in the previously uttered word.

The results of this experimental research yielded small correlation coefficients that were in the .30-.40 range comparing auditory discrimination to reading achievement. This led the investigators to suggest that "it cannot be concluded that at the intermediate grade level a substantial relationship exists between silent reading ability and the ability to discriminate sounds in a spoken language situation."*

43. Zhurova, L. E. The development of sound analysis of words in preschool children. *Soviet Psychology and Psychiatry*, 1964, 2, 11-17.

There is strong evidence that the position of the phoneme in an utterance is an important variable for the task of phonemic segmentation. Zhurova found from his investigations that isolation of final sounds is more difficult for the preschooler than isolation of initial sounds.*

VISUAL-DISCRIMINATION

44. Anderson, I. H., & Dearborn, W. F. *The psychology of teaching reading.* New York: Ronald Press Company, 1952.

Studies of misreading have revealed that three types of visual cues are used in word perception: (1) individual letters, (2) small letter groups, and (3) word shape or structure. Familiar words are perceived primarily in terms of their total structure. The perception of unfamiliar words requires greater attention to the detailed composition of the word. Children who are just beginning to read typically ignore the pattern, principally because all words are relatively unfamiliar to the inexperienced reader. The rank beginner is prone to identify words with certain compelling or "dominant" letters. The pattern materializes only through practice. What seems to happen is that, with practice, the response of recognition gradually enlists more and more of the detail until finally the word is organized as a unit and the perception of it is complete. Reading by syllables or "dominating complexes" represents an intermediate or transitional stage in this process. It is possible that the method of teaching complicates this general description of what takes place. This question is discussed as part of the analysis of the psychology of methods of teaching reading which is made in the next chapters.

45. Asso, D., & Wyke, M. Discrimination of spatially confusable letters by young children. *Journal of Experimental Child Psychology*, 1971, 11, 11-20.

A study of the ability of young children to discriminate spatially confusable letters using four different methods of discrimination (matching, copying, naming, and writing to dictation) was carried out. The subjects were 31 English children whose ages ranged from 5 years 6 months to 6 years 10 months. The test material consisted of 10 spatially confusable letters, i.e., letters whose differential features depend upon their spatial orientation: p, q, d, b, u, and n, and to a lesser extent h and y and w and m. The results show that the accuracy of discrimination of spatially confusable letters is dependent upon the method of assessment employed. The highest accuracy is achieved when the method requires copying confusable letters from a given sample, followed by the method that requires matching a given letter with other possible alternatives. Naming the confusable letters and writing them in response to dictation are the most difficult tasks to perform. The results also indicate that there is a significant correlation between individual performances in the matching, naming, and writing to dictation tests; but in the copying task individual performances varied independently of the performances in the other tests. Some theoretical implications of the findings are discussed.

46. Baldwin, A. L., & Baum, E. Interruptability of words in the speech of nursery school children. In Levin, H. (Ed.), *A basic research program on reading.* New York: Cornell Press, 1963.

The primary focus of this study is the delineation of some of the underlying units in the language of children. In this study a unit of speech is defined operationally in terms of its "interruptability." The assumption is that units are less vulnerable to being split in the middle of vocalization than non-units and the purpose is to discover such units.

The data indicates that for older subjects (4-5 years old), and some of the younger ones (3-4 years old), words often function as units. Rarely was speech stopped in the middle of words. However, in those few cases where this did occur, speech tended to be resumed not from the point of cessation, but rather from the following word. One might speculate that as far as the child is concerned, the intention was complete, or the word was completed subvocally or through some other psychological mechanism, even though speech was audibly discontinued.

One syllable words were broken in the middle about 7% of the time, whereas two syllable words were broken in the middle about 20% of the time. On the other hand, the 2-syllable word with the clearest breakage in normal speech (present) was split less often than any, in fact about like 1-syllable words.

Our data demonstrates that subjects reacted to 8 phrases in a manner similar to the way they reacted to the single test words, showing a general reluctance to stop talking until entire phrases were completed.

As one moves on to the younger children in the sample, it becomes increasingly evident that units can be something other than either words or phrases. Only one half of the 12 Juniors tested were able to learn to stop talking when the light went out. It could be that for these children, the entire sentence forms a unitary entity, making it extremely difficult for them to chip it up into smaller parts.

Our data on reaction times, however, do not support the idea that the length of time taken to stop is the same regardless of what the child is saying. A comparison of Juniors and Seniors on the four 2-syllable words showed that Juniors took significantly longer to stop. However, Juniors tended more often than Seniors not to stop after the word signaled, but rather after the following word. There was no difference between the Junior and Senior groups on reaction times to the phrases.

47. Cairns, N. U., & Steward, M. S. Young children's orientation of letters as a function of axis of symmetry and stimulus alignment. *Child Development*, 1970, 41, 993-1002.

The effects of axis of symmetry and relative position of stimuli were examined by means of a letter-orientation task administered to 60 children, 4, 5, and 6 years of age. Subject variables examined were age and eye-hand dominance (mixed vs. unilateral established). Left-right awareness and knowledge of names of stimulus letters were found to correlated with error scores. Significant effects were found for age, axis, axis X age, axis X position, and age X axis X position. The results were discussed in terms of implications for reading.

48. Caldwell, E. C., & Hall, V. C. The influence of concept training on letter discrimination. *Child Development*, 1969, 40, 63-71.

72 kindergarten children, randomly assigned to 1 of 3 warm-up groups--(1) orientation relevant, (2) orientation irrelevant, and (3) control--were required to discriminate among the letters b, d, p, and q on a task similar to Davidson's (1935) Letter Perception Test. While subjects in group 2 made significantly more confusion errors than those in group 3, subjects in group 1 made significantly fewer errors than those in group 3. The results are interpreted in terms of the adequacy of analysis of the discrimination task, that so the appropriateness of the subjects concept of same and different, rather than perceptual ability and/or attentional factors.

49. Clay, M. M. An increasing effect of disorientation on the discrimination of print: A developmental study. *Journal of Experimental Child Psychology*, 1970, 9, 297-306.

Howard and Templeton (1966) summarize research on orientation and shape discrimination and predict that "If a particular shape is seen repeatedly in orientation *the effects of relative disorientation on discrimination should increase*." This hypothesis was tested on words (mono-oriented stimuli) with a group of children during their first 3 years of reading instruction. The quality of reading progress was an independent variable. A trend towards increasing dependence on familiar orientation appeared first and strongly in the normal-reversed contrast and later and less strongly in the normal-inverted contrast. The effect of changed orientation occurred earlier for good readers and later for poor readers. Evidence for independence of familiar orientation after three years of instruction was not strong.

50. Davidson, H. P. A study of the confusing letters *b, d, p, q, j*. *Journal of Genetic Psychology*, 1935, 47, 458-468.

The purpose of this experiment was to determine with what letters and to what extent unselected young children confuse the letters *d, e, n, q,* and *b*, respectively, the chief interest being directed toward the reversal type of error.

A Letter Perception Test was devised for this purpose and given to 48 kindergarten and 111 first-grade children whose distribution of intelligence as measured by Stanford-Binet IQ's proved to be a very normal one.

The results revealed that a larger percentage of kindergarten than first-grade children made every type of error. Practically all kindergarten children confused *d* with *b*, *q* with *p*, and *b* with *d*. A smaller but substantially large percentage of first-grade children made similar errors.

The errors, with one exception, fell into two groups, namely, reversal errors and inversion errors. The one exception was the *n-h* error.

There was a marked and consistent decrease in the percentage of children making errors with increase in mental age. Between the mental ages of five and one-half and six years there was a marked decrease in the percentage of children making the following errors: *n-u, n-h, q-b, q-d, d-p, d-q, b-p, b-q*. The greatest increase in ability to avoid *d-b, p-q,* and *b-d* errors, and in the ability to select *d, q,* and *b* without any error whatever, did not occur until a mental age of at least seven and one-half years had been reached.

No evidence of a sex difference was found among the kindergarten children but a larger percentage of first-grade boys than first-grade girls made 10 out of the 11 errors studied. The one exception was the *n-h* error which is a different type of error from the others. This consistent difference suggests the presence of a real sex difference and corroborates the indications of a sex difference found by the writer in her study of form reversal and word reversal errors. It has an important bearing on first-grade reading in view of the larger number of boys who present serious reading difficulties.

These data indicate that some letters of the alphabet are more difficult to discriminate than others. The letters that are the most difficult to distinguish between are the pairs of letters that are the reversal of each other. Letters that are the upside down inversion of others are also difficult to differentiate but not nearly so difficult as reversals. Increase in ability to discriminate letters comes with increasing mental maturity and experience. This would fit in with a genetic theory of form perception.

There are indications that children pass through certain stages before they are able to distinguish between *b* and *d*, *p* and *q*. In the first stage, for example, they confuse *b* with *d*, *p*, and *q*. Apparently the fact that all four letters consist of a circle and a stem is sufficient to establish their identity. In the second stage they confuse *b* with *d* but not with *p* and *q*. The direction of the stem is apparently a determining factor. In the third stage they consider *b* and *d* to be alike although they recognize that these letters face different ways. In the final stage they recognize that *b* and *d* are actually different letters. The above indicates that young children recognize letters independently of their absolute spatial position.

51. Doob, L. W. Exploring eidetic imagery among the Kamba of Central Kenya. *Journal of Social Psychology*, 1965, 67, 3-22.

On the basis of conventional and rigorous criteria, 20 per cent of a sample of Kamba adolescents and adults in Kenya (N = 49) were found to possess eidetic imagery. That proportion, also emerging in another African society (the Ibo of Nigeria), is many times higher than the incidence in the West. Almost all the Kamba so tested claimed to have "pictures" in their heads of past events: a kind of imagery shown here to be both different from but related to eidetic and memory images. Neither eidetic nor pictorial imagery aided immediate, short-time, or long-time recall. If anything, the absence of these images was associated with better recall right after seeing the stimulus pictures. The presence of eidetic imagery was not associated with performance on a number of psychological tests nor with most census-type information, although there was a slight tendency for it to be negatively correlated with knowledge of English and formal schooling. Most subjects claimed that pictorial images are helpful to them in their daily lives: for example, by enabling them to recall the dead. The tentative conclusion reached is that eidetic and pictorial images may enable people to recall the past not more accurately but more vividly and confidently.

52. Dunn-Rankin, P. The similarity of lower-case letters of the English alphabet. *Journal of Verbal Learning and Verbal Behavior*, 1968, 7, 990-995.

The scales developed in this study generally support the findings of other studies which have isolated confusing pairs of letters such as *b-d*, *d-p*, *b-p*, *c-e*, and *n-u*. Some exceptions, however, can be noted. Where Popp (1963) found no errors between the letters *m* and *w* for pre-readers, this study indicates that second- and third-grade children often view them as similar.

Where *t* and *u* are confused in Popp's study (six errors) they were viewed as relatively dissimilar by the subjects in this study. These disparities indicate that the relative discrimination tasks could be used with younger children to account for such differences.

The fact that the pair *m*-*w* is high in order of similarity indicates that the curve-to-line transformations are easily made. The pairs *p*-*b*, *b*-*d*, *m*-*w*, *n*-*u*, and *f*-*t* indicate that rotational errors in all three spatial planes are probable sources of confusion. These findings support those of Gibson et al. (1963) who found them to be important sources of error in pre-readers.

The factor analysis reveals that the letters may be clustered together in clearly definable groups based on size, formal similarity, axial rotation, and topological line-to-curve transformations. It appears reasonable that most letters could be grossly discriminated by being assigned to one of these major clusters of letters. It is doubtful that many errors in confusion occur between letters from different orthogonal factors. It should be difficult, for example, to mistake *p* for *i*, *f*, *l*, *t*, or *k*. It is suggested that within the clusters the particular features of letters become increasingly important for discrimination.

Where other studies have assumed a reciprocity of similarity between letter-pairs, the scale values presented here indicate that this may not always hold. Subsequent retesting of students on the letter-pairs (*i*-*l*, *l*-*i*) revealed that such results are not artifacts of scaling procedure but are actual tendencies to see directional similarity for certain letter-pairs. Where subjects are faced with the task of selecting which of two letters, *i* or *k*, *h* or *i*, and *t* or *i*, is more like a second stimulus, they more often select *k*, *h*, or *t* than *i*.

A suggested principle of learning is to present materials that offer the opportunity for maximum contrasts before moving to items with minimal cues for discrimination. Since the scales presented in this study are indices of letter similarity, they will also show which letters are most unlike each other. In the teaching of letter discrimination teachers could focus attention on either similarities or differences in an effort to test the efficacy of instructional emphases.

53. Elkind, D., & Weiss, J. Studies in perceptual development, III: Perceptual exploration. *Child Development*, 1967, 38(2), 553-561.

85 children, from 5 to 8 years of age, were presented with structured and unstructured arrays of familiar figures and asked to name them. Results showed that the tendency to explore an unstructured array systematically increased with age. Exploration of the structured array, however, was systematic at all age levels tested. The results were interpreted as supporting the position that perceptual performance is a joint function of the child's level of perceptual development and the nature of the stimulus configuration. Additional findings were interpreted as supporting the view that patterns of visual exploration are, in effect, motor skills.

54. Fisher, D. F., Monty, R. A., & Glucksberg, S. Visual confusion matrices: Fact or artifact? *Journal of Psychology*, 1969, 71, 111-125.

Perceptual confusion matrices were generated with the use of tachistoscopic exposure of upper case letters of the English alphabet at each of two exposure durations. The resulting matrices were compared with those generated by Hodge (1962) and Pew and Gardner (1965). Little correspondence was noted between the pattern of confusions obtained in each study. Thus, there was no evidence for the common assumption that a basic "pattern of confusions" exists between letters of the alphabet. Implications for studies of short-term memory were discussed.

55. Gibson, E. J., Bishop, C. H., Schiff, W., & Smith, J. A comparison of meaningfulness and pronunciability as grouping principles in the perception and retention of verbal material. In Levin, H. (Ed.), *A basic research program on reading*. New York: Cornell Press, 1963.

Thresholds of visual perception and two measures of retention were obtained for trigrams varying in pronunciability and meaningfulness (semantic reference of the kind found in well-known initials) and for control items. The three types of trigrams contained the same letters rearranged anagram-wise. Perceptual thresholds were lowest for pronounceable items, and next lowest for meaningful ones. On the other hand, retention, measured by both recognition and free recall, was best for the meaningful items and second best for pronounceable ones. Pronunciability was inferred to be the better grouping principle for reading or coding to speech units. Meaningfulness was inferred to have facilitated retention more than pronunciability by providing a category for grouping the initial items, thus aiding retrieval.

56. Gibson, E. J., Gibson, J. J., Pick, A. D., & Osser, H. A developmental study of the discrimination of letter-like forms. *Journal of Comparative and Physiology Psychology*, 1962, 55, 897-906.

This experiment studied qualitatively as well as quantitatively the development of visual discrimination of letter-like forms in children four through eight. The forms were constructed according to the same constraints which govern formation of printed capitals. Twelve were chosen as standards, and twelve specified transformations were constructed for each standard. The transformations were three degrees of change from line to curve or vice versa; five changes in orientation; two perspective transformations; and two topological transformations. The discrimination task required subject to match a standard form with an identical form. All subjects matched for all twelve standards. Errors were classified according to type of transformation erroneously identified with the standard. The experiment was repeated for the 5-year-old group using real letters.

Overall error scores decreased with age, but difficulty of discrimination was different for different transformations. Initial errors were greatest for perspective transformations and least for topological transformations, with changes of rotation and reversal in between. Changes of line to curve varied in difficulty depending on the number of changes.

The slopes of the curve differed, as well as the initial error. The four classes of transformation showed similarity of slope within the class, but significant differences between them. Errors made with real letters correlated significantly with errors made with letter-like forms. The correlation between mean errors for different transformations in the two sets of material was +.87, showing that the kind of transformation defining similarity or difference between two forms is a good predictor of confusion errors.

The differences between the developmental error curves for the four types of transformation were interpreted in terms of a hypothesis of distinctive features. Features which have been in the past critical for distinguishing objects are assumed to transfer to graphic discriminations. Discrimination learning continues from this point for distinctive features of letters, but proceeds slowly, if at all, for those varying features of graphemes which are not critical for distinguishing them.

57. Gibson, E. J., Osser, H., Schiff, W., & Smith, J. An analysis of critical features of letters, tested by a confusion matrix. In Levin, H. (Ed.), *A basic research program on reading.* New York: Cornell Press, 1963.

An analysis of the differences between graphemes of a specified type was made in terms of potential distinctive features of grapheme. Two feature lists, both of which gave a unique pattern of features for each of 26 letters, were used to predict errors in a confusion matrix obtained with the same letters. The subjects (four-year-old children) performed a matching task with the letters. For both feature lists, the percent feature difference between letters was correlated with the errors. An overlap measure was also correlated with the errors. The number of significant correlations was far greater than chance for all three measures, the second feature list being the best predictor. The choice of certain feature dimensions (curve-straight and obliqueness) was corroborated by a multi-dimensional analysis of the matrix.

58. Gibson, E. J., & Yonas, A. A developmental study of visual search behavior. *Perception and Psychophysics,* 1966, 1, 169-171.

Children in second, fourth and sixth grades and college sophomores were compared on a visual search and scanning task under three experimental conditions. In Condition I, a single target letter was sought in a list of letters of low visual confusability. In Condition II, two target letters were sought but only one appeared in a given list. In Condition III, a single target letter was sought in a list of letters of high confusability. Search time decreased with age in all three tasks. Searching for two targets was no harder than searching for one. A highly confusable visual context increased search time at all age levels.

59. Gibson, J. J., & Osser, H. A possible effect of learning to write on learning to read. In Levin, H. (Ed.), *A basic research program on reading.* New York: Cornell Press, 1963.

The hypothesis is that practice in letter-making will facilitate letter-recognition. It is assumed that the essence of letter making is the leaving of a visible mark specific to the motor act... For testing this hypothesis, an experimental group of children was given a pretest and a posttest of letter-recognition, with intervention practice in making letters by pressing the keys of a typewriter. A control group was treated in exactly the same way and performed the same motor reactions but without leaving traces. These children could feel and see the action of the type-bar, like the others, but the surface remained blank. Twenty children from 4- to 6-years old from day camps run by the Ithaca Board of Education served as subjects.

There is some evidence that the Experimental Group learned more than the Control Group since they named a greater number of letters correctly on the posttest than the Control Group did. A comparison of the number of errors made during practice by the two groups shows the same trend.

Notwithstanding the small number of subjects used the results suggest that the additional practice in letter-making over and above the association of pretested letters with their names and the association of pretested letters with motor acts as such enabled the experimental subjects to perform better than the controls. The hypothesis was that practice in letter-making (writing) facilitates letter recognition (reading). The experimental subjects could see their own typing production; the Control subjects were unable to see their own typing production. The results support the hypothesis.

60. Gilbert, L. C. Saccadic movements as a factor in visual perception in reading. *Journal of Educational Psychology*, 1959, 50(1), 15-19.

The findings of the investigation may be summarized as follows:

1. These data indicate that both good and poor readers make more perceptual errors when they read with eye movements than they do when reading without movements.

2. Both good and poor readers make fewer perceptual errors reading at the 2/24 second level without saccadic movements than they do reading at the 4/24-second level with saccadic movements.

3. Saccadic movements are associated with a substantially greater loss in visual perception for the poor readers than they are for the good readers.

4. Slow readers seem to need, as a group, a longer interval of time to stabilize their fixations to a point of maximum efficiency than is necessary for the fast readers.

5. Both good and poor readers can process simple prose material mentally at a faster rate and more accurately than they actually do when reading with saccadic movements.

61. Gould, J. D., & Schaffer, A. Eye-movement parameters in pattern perception. Research Paper, May 12, 1966, IBM Research, Yorktown Heights, New York.

The two main findings of this study confirm both of the individual hypotheses: subjects tend to look longer at visual patterns they are looking for than at visual patterns they are not looking for, and they also look longer at patterns which exactly match a standard pattern than at those that differ from this standard.

It is tempting to generalize the finding of longer fixations on target patterns to other types of stimuli. While the limits of this generalization are not yet known, limits do exist, since no difference between the duration of fixations on targets and the duration of fixations on non-targets occurs for targets and non-targets defined by the arithmetic sums of three digits (Gould & Schaffer, 1965c). While it might be thought that the longer duration of fixations on target patterns is due, at least partially, to the process of counting targets, the study just cited does not support this assumption, since those subjects were required to count targets also, and the duration of fixations on targets was not longer than duration of fixations on non-targets.

The second main finding suggests that subjects make definite analytic comparisons of the details and differences between a standard pattern and a given fixated pattern, as opposed to perceiving a fixated pattern in a more immediate or holistic way. Given the assumption that subjects do make these comparisons, then the fact that more time is taken to process a pattern which matches a memorized standard than one that differs from this standard is, of course, not surprising. In perceiving a match, a "complete" set of comparisons is required, whereas in perceiving a non-match, a "complete" set of comparisons is typically not required, since the detection of a single difference is sufficient. If, on the other hand, patterns were perceived in a more immediate or holistic way, the explanation of longer fixations on patterns that match a memorized standard pattern than on patterns that differ from this standard is not obvious. These differential fixation durations also suggest that these comparisons are not carried out entirely in parallel.

62. Gould, J. D., & Schaffer, A. Eye-movement parameters in pattern recognition. *Journal of Experimental Psychology*, 1967, 74(2), 225-229.

In visually scanning nine simultaneously presented patterns, human subjects fixated significantly longer (a) on patterns they were looking for (i.e., on targets) than on patterns they were not looking for; and (b) on patterns that exactly matched a memorized standard pattern than on patterns that differed from this standard. These results suggest that (a) subjects may have a generalized tendency, within certain limits, to look longer at stimuli they are looking for than at stimuli they are not looking for; and (b) subjects make definite analytic comparisons of the details and differences between a memorized standard pattern and a given fixated pattern, as opposed to detecting a fixated pattern in a more immediate or holistic manner.

63. Haith, M. M., Morrison, F. J., & Sheingold, K. Tachistoscopic recognition of geometric forms by children and adults. *Psychonomic Science*, 1970, 19(6), 345-348.

Preschool children and college adults were presented pictures of simple outlined geometric forms at tachistoscopic exposure durations of 5, 10, 20, 30, and 40 msec. When accuracy was plotted as a function of exposure duration, the curve of 5-year-olds approximated that of adults. However, 5-year-olds reached given performance levels at exposure durations that were 5-10 msec longer than those of adults. The age differences, considered to be relatively minor, were discussed in terms of faster visual processing time and better usage of partial cues by adults. It was concluded that the use of stimulus durations that do not permit eye movements is feasible in studies of preschool subjects. Thus, hypotheses about the development of visual operations in information processing can be tested without confounding the influence of age differences in visual scanning.

64. Haltrecht, E. J., & McCormack, P. D. Monitoring eye movements of slow and fast learners. *Psychonomic Science*, 1966, 6(10), 461-462.

Eye Movements of slow and fast learners were monitored as they studied a 7-item P-A list. The findings were consistent with a two-stage interpretation of verbal learning. The slow learners appeared to take longer in Stage 1, a relatively brief process, and to experience considerable difficulty in Stage 2.

65. Hill, M. B. A study of the process of word discrimination in individuals beginning to read. *Journal of Educational Research*, 1936, 29, 487-500.

The specific aim of this experiment was to study analytically at the beginning level and in normal readers some types of errors in word discrimination that investigators have reported at various levels of reading attainment.

The initial pattern showed the characteristics listed below:

1. As compared with the middle, the beginnings and ends of words were most frequently observed and used as cues.

2. The middle section of the words was seldom observed and therefore gave rise to most errors.

3. Single nonreversible letters were discriminated quite adequately when presented in isolation.

4. Identical configuration between two words caused few errors, the percentages of error being 5.27 and 1.08 for test and retest respectively.

5. An analysis of the cues and details tests from the point of view of the proportion of the words remaining constant regardless of what aspects of the words were involved showed that the larger the proportion of identity between two words, when configuration was considered as one aspect of that identity, the more confusing the two words were.

6. When the letters and the configuration remained the same, the order of the letters gave rise to a relatively large number of errors.

7. The addition or omission of one letter in words otherwise remaining the same was not observed in a relatively large number of cases in the initial tests (29.5 percent). This percentage dropped to 9.20 on the retests. The position of the addition or omission apparently was not a factor.

8. Disorientation was present in a continuum of degrees from practically no disorientation to apparently complete disorientation so far as the letter forms tested in this study are concerned.

9. Reversible letters appearing in words cause more difficulty than those same letters appearing in isolation or the disorientation of the whole word or a part of it.

10. The horizontal disorientation test items showed a reliably higher incidence of error than either of the other directions of disorientation on both the initial tests and the retests.

66. Huey, E. B. *The psychology and pedagogy of reading.* Cambridge, Massachusetts: MIT Press, 1968.

In experiments made some years ago it was noted that the first half of a word is of considerably greater importance for perception than is the latter half. ...It will be recalled that the beginning of a word was regularly found to be a determining or dominating part, in some of the exposure experiments. Indeed, the terminal letters are considerably more legible than the others perhaps from being partially isolated. Fixate the middle of one of the long words and you will probably find yourself much more conscious of the end letters than of many of the interventing ones. The writer made a quantitative test of the comparative importance of the first and last halves of words by having readers read passages from which the first half of each word was carefully removed in the one case, and the second half in the other. It was found that more words were made out, and in less time, when the first halves were read than when the latter halves alone remained. The four readers tested averaged .49 words per second when reading from the first halves, as against .33 words per second when reading from the last halves.

The upper half of a word or letter is obviously more important for perception than is the lower half. This may be tested by comparing the difficulty of reading and two mutulated passages below, the unmutulated passage being the same type.

67. Jeffrey, W. E. Variables in early discrimination learning: I motor responses in the training of a left-right discrimination. *Child Development*, 1958, 29, 269-275.

An experiment was devised to test the facilitative effect of attaching simple motor responses to stimuli differing in spatial (left-right) orientation on the subsequent labeling of these stimuli. Four-year-old children were used as subjects and it was found that, except for a few children who learned the labeling task with ease, the majority of four-year-olds found the task essentially impossible.

The experimental treatment of learning to press buttons oriented in the directions the stick figures used as stimuli were pointing was readily learned by all subjects in the experimental group and this training was found to have a significant effect on subsequently learning to apply labels.

68. Karraker, R. J., & Doke, L. A. Errorless discrimination of alphabet letters: Effects of time and method of introducing competing stimuli. *Journal of Experimental Education*, 1970, 38(4), 29-35.

Kindergarten children were first trained to discriminate the letters b and d when those letters were first presented in succession. The children were divided with respect to the time and manner in which competing stimuli (S^{Δ}s) were introduced during training. Early-late and progressive-constant dimensions of the method of S^{Δ} introduction were employed, which resulted in four conditions: Early-Progressive (EP), Late-Progressive (LP), Early-Constant (EC), and Late-Constant (LC). Subsequently, the children were trained to discriminate b's and d's presented simultaneously. Following this simultaneous discrimination training, stimuli were again presented in succession. Performance was analyzed in terms of the proportion of errors emitted in the presence of S^{Δ}s.

Progressive and early methods of S^{Δ} presentations were found to be most functional in minimizing errors during both simultaneous and successive discrimination training. Comparisons of error proportions during acquisition of the successive discrimination, to error proportions during later successive dicrimination, suggested differential effects generally favorable to EP and unfavorable to LC method of presentation.

69. Leslie, R., & Calfee, R. C. Visual search through word lists as a function of grade level, reading ability, and target repetition. *Perception and Psychophysics*, 1971, 10(3), 169-171.

Second-, fourth-, and sixth-grade students of high or low reading ability and college students carried out a visual search task in which they scanned a list of 10 words; looking for a target word which was changed every trial or remained constant during an entire session. Search time increased linearly with serial position, constant with a serial self-terminating model of visual search. The search rate increased from 3.3 words/sec in the second grade to 8.4 words/sec in college. Reading ability was not a significant factor in any comparisons. These results on the development of visual search ability agree with others showing that with increasing age there is a marked increase in search speed. However, retarded readers are as competent as their age peers on this task, suggesting that reading dysfunction must be traced to other deficiencies.

70. Lott, D. Visual word recognition: Its implications for reading research and instruction. Technical Report No. 17, July 7, 1969, Southwest Regional Laboratory, Inglewood, California.

Evidence that words are recognized more easily than letters alone has been available since the early studies of Cattell (1885; 1886). This phenomenon, while seldom questioned, has never been adequately explained. Educators have accepted the skilled reader's tendency toward total word recognition as a basic reading skill, but have made little attempt to identify the nature and development of this skill in reading acquisition.

This paper describes a model of the processes involved in word recognition and suggests how these processes can be put to use in reading instruction. The model describes word recognition as a feature scanning process in which relevant cues, called distinctive features, are analyzed and synthesized.

71. Lott, D., Smith, F., & Cronnell, B. Functional equivalence of feature combinations in the visual identification of words. Technical Report No. 8, August 15, 1968, Southwest Regional Laboratory, Inglewood, California.

It is proposed that the normal adult reader does not attend to individual letters but to sets of features which are characteristic of a word as a whole. A total of 216 college students served as subjects. The results of this experiment support the hypothesis that disruption in the "total word form" does not interfere with one's ability to identify words unless discriminability of elements is disrupted, for example by mixing the size of the individual letters. The only unpredicted finding was that alternating the size of upper case letters interfered with the identification of words in a search-and-identification task whereas it did not interfere with reading upper case print when some comprehension and verbalization of response were involved.

72. Lyle, J. G., & Goyen, J. Visual recognition, developmental lag, and strephosymbolia in reading retardation. *Journal of Abrnomal Psychology*, 1968, 73(1), 25-29.

Three sets of tachistoscopically projected stimuli (letters of alphabet, lines, and word shapes) were each presented under three conditions of visual recognition (immediate, delayed, and sequential) to a group of retarded readers and a control group of adequate readers. Controls and experimental subjects were screened for visual and auditory acuity, matched for grade placement, and were within the average range of intelligence. Experimental subjects performed less well than controls on all nine tasks, with differences in perceptual speed suggested as a reason. Differences were greater at the younger age levels, supporting the developmental lag theory. The data were also analyzed for reversal errors.

73. Marchbanks, G., & Levin, H. Cues by which children recognize words. *Journal of Educational Psychology*, 1965, 56(2), 57-61.

To discover the bases on which children recognize words, 50 kindergarten and 50 first grade children were required to select from a group of pseudowords, the one similar to a word that had just been exposed to them. Each word in the response group contained one cue that was the same as the stimulus word, with the other cues held constant. Specific letters, and not the overall shape of the words, form the basis for recognition. The first letter is the most important cue; the final letter is the second most important. In three letter words the last letter is a more salient cue than in five letter words.

74. McFarland, J. H. The effect of part sequence on succession threshold. *Perception and Psychophysics*, 1970, 7(2), 91-93.

When letters of the word POT and the nonsense syllable OTP are presented in a typical orientation (horizontal) and a typical order (left to right, up to down), succession threshold is lower relative to presentation in an atypical orientation (vertical) and an atypical order (right to left, down to up). These results are interpreted as showing that learning to read English establishes both orientation and order parameters of a hypothetical analysis operation.

75. Nodine, C. F., & Evans, J. D. Eye movements of prereaders to pseudowords containing letters of high and low confusability. *Perception and Psychophysics*, 1969, 6(1), 39-41.

Children were required to make same-different judgments about matched and unmatched pseudoword pairs containing middle letters of either high confusability (e.g., ZPRN) or low confusability (e.g., EROI). Differential eye-movement patterns were observed between matched and unmatched low-confusion pairs. This finding would be predicted from a features analysis of the visual characteristics of the letters of the pseudowords. Low-confusion pseudowords contain more diffierent visual features than high-confusion pseudowords. Therefore, in making a matching judgment, low-confusion pairs should require more eye movements; however, detection of a mismatch should be facilitated due to the greater availability of distinctive features.

76. Nunnally, J. C., Faw, T. T., & Bashford, M. B. Effect of degrees of incongruity on visual fixations in children and adults. *Journal of Experimental Psychology*, 1969, 81(2), 360-364.

In two experiments, one with children and one with adults, visual fixations were measured while subjects viewed pairs of outline drawings. Four sets of stimuli were shown to subjects, with four pictures in each set. Each set was constructed in such a way as to represent four levels of incongruous juxtaposition of animal or object features. In both experiments, monotonically increasing relationships were found between degree of incongruity and amount of viewing time. The results support a theory of visual selection concerning the resolution of informational conflicts rather than a theory concerning optimal levels of arousal.

77. Ohnmacht, D. C. Effects of instruction in letter knowledge on achievement in reading in the first grade. Unpublished manuscript, University of Missouri, no date available.

This study investigated the relative effects of the selective ordering of instruction in letter names, letter names and sounds, and sight words on achievement in word knowledge, word discrimination, and comprehension. Two hundred and eight 1st grade subjects were assigned to one of three treatment conditions. Treatment Group A received instruction in letter names followed by the teaching of sight words. Treatment Group B received instruction in letter names and sounds followed by the teaching of sight words. Treatment Group C received instruction in sight words followed by the teaching of letter names and sounds. Comparisons were made for subjects in three treatment groups in the total sample, for subsamples of subjects on several intelligence levels, and for subsamples of subjects on several reading readiness levels.

Criterion consisted of tests of word knowledge, word discrimination, and comprehension of sentences and paragraphs. Prior knowledge of letter names, of prior knowledge of letter sounds, of information and oral language comprehension, and intelligence provided data utilized as covariates. Scheffe's Test was employed to compare adjusted means on criterion scores following rejection of any null hypothesis.

Initial instruction in letter names and sounds produced greater achievement in word knowledge and word discrimination than did initial instruction in sight words. Comparisons at several intelligence levels indicated this general superiority to be a function of significant differences for children of average intelligence only. When comprehension was the criterion there was no general treatment effect detected. However, initial instruction in letter names and sounds produced superior results for children who were average on measures of reading readiness.

Initial instruction in letter names appears of value to reading achievement mainly for children below average on measures of reading readiness and then only in word perception.

78. Pick, A. D. Improvement of visual and tactual form discrimination. *Journal of Experimental Psychology*, 1965, 69(4), 331-339.

A discrimination-learning situation and subsequent transfer tests were used to investigate two hypotheses about improvement in discrimination: a "schema" hypothesis and a "distinctive feature" hypothesis. One visual and two tactual discrimination experiments were conducted. Results suggested the superiority of the distinctive feature hypothesis, at least under conditions of a simultaneous comparison, for accounting for children's improvement of discrimination of the letter-like forms used as material.

79. Popp, H. M. Visual discrimination of alphabet letters. *Reading Teacher*, 1964, 17(4), 221-226.

The ability to observe similarities and differences in two-dimensional stimuli is considered a prerequisite to reading instruction by many reading authorities, and studies comparing ability in visual discrimination with later reading achievement most frequently report significant correlations. The present study was designed to measure the "confusability" of pairs of graphemes in a simple matching task for five-year-old children as a means of determining relative difficulty in discriminating such pairs.

The influence of similarity within the complete set of twenty-six letters can be assessed (rather than ranking individual letters as to "confusability" as Smith did). The results seem to substantiate the analysis as outlined thus far by Gibson as confusions arise from reversals and rotations (*p-q*, *b-d*, *b-q*, *d-p*, *b-p*, *n-u*) and not from close and break transformations (*o-c*).

Apparently some confusions in this study were also caused by a high degree of formal similarity (the proportion of similar or identical lines contained in both graphemes, e.g., *i-l*, *k-y*, *h-n*).

It would seem that consideration of the distinctive features and of the formal similarity of letters should provide insight for training a specific skill in visual discrimination for letters. Remaining as a matter for further research is the problem of determining whether children trained to discriminate highly confusable letters on the basis of distinctive features and/or formal similarity will then be able to accurately discriminate all letters, and whether such training will have any effect on their later reading achievement.

80. Posner, M. I., & Keele, S. W. Decay of visual information from a single letter. *Science*, 1967, 158, 137-139.

If the trace of a letter can be matched more rapidly with a physically identical letter (as in the pair AA) than it can be with a letter having only the same name (as in the pair Aa), then the trace must preserve the visual aspect of the letter. The visual information from a single letter decays in about 1.5 seconds if the task provides little incentive for preservation.

81. Rudel, R. G., & Teuber, H. L. Discrimination of direction of line in children. *Journal of Comparative and Physiological Psychology*, 1963, 56, 892-898.

Two experiments were performed demonstrating similarity of pattern-discrimination learning in children to that of the octopus described by Sutherland. Young children (ages 3-4) confuse oblique lines oriented in opposite directions, just as the octopus does, although they can readily discriminate vertical from horizontal lines--again as seen in the cephalopod. Analogous results were obtained for ∪ shapes in various orientations; transfer trials confirmed the lack of discrimination for obliques.

82. Samuels, S. J., & Jeffrey, W. E. Discriminability of words, and letter cues used in learning to read. *Journal of Educational Psychology*, 1966, 57(6), 337-340.

The 36 kindergarten subjects were distributed among three groups. Using the paired-associate anticipation method, each group was taught 1 of 3 lists of words that differed in discriminability. Discriminability was determined by the number of different letters (either 4, 6, or 8) used to construct 4 2-letter words. It was hypothesized that the more discriminable the list, the faster the learning rate but the greater the probability that subjects would learn on the basis of single letters. The hypothesis concerning learning rate was confirmed with $p < .01$. After the 4- and 8-letter groups were brought to the same criterion, the 8-letter group was found to identify words on the basis of single letter cues significantly more often ($p < .02$) than the 4-letter group, thus confirming the 2nd hypothesis as well.

83. Tinker, M., & Paterson, D. Eye movements in reading a modern face and Old English. *American Journal of Psychology*, 1940, 54, 113-115.

In five determinations of the difference in speed of reading Old English (Cloister Black) in comparison with a modern type face (Scotch Roman) we found a differential effect in favor of

Scotch Roman ranging between 11.6 and 14.2%. The consistency of this striking difference naturally suggests the desirability of searching for the specific differences in the eye-movement patterns underlying this retardation.

We interpret the obtained differences to indicate the difficulties experienced by our readers in grasping word and phrase units. This forces the reader to a discrimination of details which ordinarily would be at a minimum. As a matter of fact, inspection of the printed copy reveals that characteristic word forms are distorted in Cloister Black printing. In addition, many of the letters are difficult to discriminate.

1. Performance reading tests have uniformly shown that Old English is read about 12% more slowly than ordinary type face.
2. Eye-movement photographs of a new group of 20 subjects indicate that the reading of Old English tends to reduce the span of perception, to increase the number of fixations, total perception-time, and the number of regressive movements. There is a suggestion that pause duration is also slightly increased.
3. It is suggested that the difficulty encountered in reading Old English type is due to the necessity for discriminating details in the perception of word and phrase units.

84. Thomas, H. Children's tachistoscopic recognition of words and pseudowords varying in pronounceability and consonant-vowel sequence. *Journal of Experimental Psychology*, 1968, 77(3), 511-513.

Three letter words and pseudoword trigrams varying in consonant-vowel order and pronounceability were presented tachistoscopically to ninety 1st, 2nd, and 3rd grade subjects. The hypothesis that recognition accuracy should be facilitated with trigrams of high pronounceability, independent of consonant-vowel order, was not confirmed. Recognition accuracy does not appear to be a simple function of pronounceability as has been maintained.

85. Vurpillot, E. The development of scanning strategies and their relation to visual differentiation. *Journal of Experimental Child Psychology*, 1968, 6, 632-650.

The oculo-motor activity of seventy-eight children between 3 and 9.6 years of age was recorded during a task of perceptual differentiation. The stimuli were six drawings of pairs of houses; the two houses were identical on three pairs, they differed by the properties of one, three, or five windows on the other three pairs. Instructions were given to answer "same" or "different" as soon as a decision was reached. The corneal reflection of the stimuli was filmed during the performance, thus allowing the experimenter to measure the location, duration, and sequence of eye fixations between the moment a stimulus appeared and the moment the judgment was uttered. Results were treated by analysis of variance.

Under 6 years of age, the children scanned only a limited part of each stimulus and judged two houses to be identical or different on the basis of insufficient information. An appropriate method of paired comparisons appeared at age 5 and was adopted by the great majority of children over 6.

An attempt was made to relate the information gathered by visual scanning and the judgment uttered, and to determine the criteria of identity and of difference, and their evolution with age.

86. White, S. H., & Plum, G. E. Eye movement photography during children's discrimination learning. *Journal of Experimental Child Psychology*, 1964, 1, 327-338.

Two experiments are reported in which 3-per-second photographic records of eye movements were made while nursery school children attempted learning set series of eight discrimination problems. Children given a series involving interesting and distinctive stimuli performed better, and showed more eye movements, than children given a difficult series. Several findings suggested that eye movements increase as learning becomes optimal, and decrease thereafter. Evidence of sudden learning in these and other data is presented.

87. Williams, J. P. Effects of discrimination and reproduction training on ability to discriminate letter-like forms. Paper presented at AERA meeting, February, 1968. ERIC ED 017 418.

To learn to differentiate and recognize letters is one of the primary steps in learning to read, and this task is often a major source of difficulty in reading instruction. Some letters are merely rotations and reversals of others, for example, lower case b and d, and p and q. It is these letters, of course, that produce the most confusion and difficulty.

88. Williams, J. P. Training kindergarten children to discriminate letter-like forms. *American Educational Research Journal*, 1969, 6(4), 501-514.

Discrimination training in which the comparison stimuli were transformations was superior to discrimination training where the comparison stimuli were totally different forms. This suggests that the comparisons involving minimally different stimuli did force the subject to attend to and abstract more attributes of the standard, which were then available for new test comparisons. Reproduction training was not as effective as discrimination-with-transformations, but was as effective as the simple discrimination training. These results suggest that in reproduction training the subject was focusing on the standards to the same extent at least as in simple discrimination training, though less than in the discrimination-with-transormation training. Thus, in terms of the Gibson hypothesis, it is suggested that the number of attributes that will be abstracted by reproduction training as compared to discrimination training does indeed depend on the similarity of the forms used in the discrimination training.

The crucial point is that even after a rather small amount of training at an appropriate level (i.e., at the beginning of the kindergarten year), there were significant differences among the training groups. These data indicate clearly that the effectiveness of readiness training does indeed depend on the particular technique used, and that there would be wide variation in the effectiveness of typically-used readiness materials. While special attention is often given to practice on rotations and reversals, usually too much time is devoted to copying and tracing or to discrimination exercises that--according to these data--are relatively ineffective. Moreover, such systematic training is sometimes given only in remedial work, that is, after a child has already developed some difficulty. The present experiment suggests (1) that more time be devoted to discrimination training that involves comparison of letters with their transformations, and (2) that this type of training be given early. It is quite effective at the very start of kindergarten, and obviously, if the occurrence of certain relatively common perceptual confusions could be minimized by appropriate training techniques introduced in the beginning stages of instruction, there should be less necessity later for remedial techniques.

89. Williams, J. P., Blumberg, E. L., & Williams, D. V. Cues used in visual word recognition. *Journal of Educational Psychology*, 1970, 61(4), 310-315.

Using delayed matching-to-sample, subjects chose from an array the nonsense trigram or quingram that most resembled the stimulus item. Each choice represented one particular error in word recognition, that is, matching on the basis of individual letters or on overall shape of the word. Kindergarten children (nonreaders) showed no consistent cue selections. First graders (beginning readers) matched on the basis of initial letter most frequently, then on final letter. They very seldom used overall shape. Adults (proficient readers) used complex strategies, including both visual and aural matching, and some adults used shape as a basis for choice.

90. Yonas, A., & Gibson, E. J. A developmental study of feature-processing strategies in letter discrimination. Unpublished manuscript, Cornell University, undated.

The question we were concerned with was whether people can change their perceptual processing strategies to include tests for the presence of only those stimulus features necessary for the task at hand.

The method was to set up an experimental situation where it would be possible, given practice, for the subject to differentiate the displays presented on the basis of a single distinctive feature, as contrasted with a control condition where an equally economical search would not be possible. If performance in the experimental and control conditions is initially the same but learning curves show asymptotic performance to be lower in the experimental condition, we infer that the perceptual process has taken advantage of the potential strategy and narrowed the search to the single feature, thus reducing the information processed before the decision is made. We asked whether such learning occurs in the course of practice and whether the ability to use such optimal strategies improves with age. We therefore compared the performance of second, and sixth grade children with that of college sophomores over 135 trials of practice.

Grade and condition did not yield a very significant interpretable interaction. The youngest children, despite the fact that their responses are much slower, show the same greater decrease in latency for the ANV condition as do adults. If the younger children are actually not as adept at switching to an economical processing strategy as adults, perhaps this is made up for by the advantage of their not having to overcome long-practiced habits of exhaustive processing of a complete feature list.

The authors believe, therefore, that perceptual learning occurs--and it is an adaptive, self-regulating change in the direction of reducing the information to be processed. At this point, the question of where and how these changes in processing strategy occur is unanswered.

AUDITORY-VISUAL INTEGRATION

91. Asher, J. J. Vision and audition in language learning. *Perceptual and Motor Skills*, 1964, 19, 255-300.

The primary purpose was to present data for the transfer of learning from one sensory modality to another, specifically the relationship between vision and audition. The parameter was a range of natural languages including Spanish, Japanese, Russian, Turkish, and Persian. The secondary purpose was to suggest some theoretical constructs which may account for the data, and the third purpose was to explore certain side issues such as pronunciation shock and the validity of predictors for paired-associate learning. There was positive transfer of large magnitude from *vision to audition* for Spanish, Japanese, Turkish, or Persian, but a small, negative transfer for Russian. There was positive transfer from *audition to vision* for Spanish, Japanese, and Russian, but transfer was neutral for Turkish and negative for Persian. The magnitude of the positive transfer was usually higher from vision to audition than audition to vision. Much of the transfer data seemed to be accounted for with a *phonetic fit hypothesis* and a *central mediation hypothesis of sensory process*. The first concept, that of phonetic fit, postulates that positive transfer will be a function of the congruent match between the spoken and written language. The greater the congruency, the higher the probability of positive transfer between sensory channels. The second concept, the central mediation hypothesis, suggests that the direction and amount of transfer is a function of data processing *not* at the sensory receptor level, but at some centralized location in the brain.

92. Birch, H. G., & Belmont, L. Auditory-visual integration in normal and retarded readers. *American Journal of Orthopsychiatry*, 1964, 34, 852-861.

The relation of auditory-visual integration to reading retardation was studied in 200 children nine and ten years of age. One hundred and fifty were retarded readers and 50 were normal readers. The retarded readers were significantly less able to make judgments of auditory-visual equivalence than were the normal readers. Within the two groups of readers, those children with lower auditory-visual performance tended to have the lower reading scores. When children with low normal IQ were eliminated from consideration, the significant difference in auditory-visual test performance between the retarded and normal readers was sustained. The findings were interpreted to indicate that the development of auditory-visual integration has specific relevance to reading, although it is not the sole factor underlying reading incompetence.

93. Birch, H. G., & Belmont, L. Auditory-visual integration, intelligence and reading ability in school children. *Perceptual and Motor Skills*, 1965, 20, 295-305.

The developmental course of auditory-visual equivalence was studied in 220 elementary school children. It was found that improvement in auditory-visual integration was most rapid in the earliest school years and reached an asymptote by the fifth grade. The correlations obtained between IQ and auditory-visual integration suggested that the two features of functioning were associated but not synonymous. In contrast, the correlations between IQ and reading ability rose with age. These opposing age trends in correlations found between reading ability and auditory-visual equivalence and between reading ability and IQ are interpreted in terms of the possible attenuating effect introduced by the low age ceiling of the auditory visual test and the possibility that in acquiring reading skill primary perceptual factors are most important for initial acquisition but more general intellectual factors for later elaboration.

94. Birch, H. G., & Lefford, A. Intersensory development in children. *Monographs of the Society for Research in Child Development*, 1963, 28, 2-47.

The relationships among visual, haptic, and kinesthetic sense modalities were explored for geometric form recognition. One hundred and forty-five pupils of a suburban public elementary school served as subjects. Their ages ranged from 5 to 11 years, and their median IQ was 115. The method utilized was a modification of the paired comparisons method. A standard stimulus presented to one sense modality was compared with variable stimuli in another sense modality. Judgments of similarity and difference were made by the subjects.

The experiment resulted in the following main findings:

a. It was found that the ability to make the various intersensory judgments clearly improved with age. The improvement in function appeared to be adequately described by a typical logarithmic growth curve which supports the view that the development of intersensory functioning follows a general law of growth.

b. By the eleventh year, there appeared to be a minimum of errors under all the conditions of the experiment.

c. It was also noted that differences among the subjects in the ability to make correct intersensory judgments tended to decrease with age.

d. It was found that, by age 5 years, over 50 per cent of the subjects were making two or less errors in intersensory judgment under the conditions of the experiment. This indicates that some aspects of intersensory judgments are well developed by school entrance age. However, full effectiveness in the utilization of intersensory information is not reached until a later stage of development.

e. It was found that it was generally more difficult to make intersensory judgments of identical forms than intersensory judgments of nonidentical forms.

f. Girls were found to make significantly fewer errors than the boys at three age levels under various conditions of the experiment. The findings, however, do not warrant any generalization about relative superiority.

g. In order to evaluate the intrasensory effects as independent from the intersensory effects, an analysis was made of intrasubject response patterns. It was found that the chief developmental findings were reconfirmed.

These findings were discussed with respect to the development of intersensory functioning and its relation to adaptive capacity.

95. Budoff, M., & Quinlan, D. Reading progress as related to efficiency of visual and aural learning in the primary grades. *Journal of Educational Psychology*, 1964, 55, 247-252.

Evidence suggests that children with various discrete deficiencies in aurally and visually dependent skills learn to read more slowly than expected. In the present study, learning efficiency of 28 average and 28 retarded second grade readers was compared when meaningful words were presented aurally and visually in a paired associates paradigm. It was hypothesized that the retarded readers would display a more discrepant rate of learning on the two modality-based presentations. Aural reading was more rapid for both the average and the retarded readers. Retarded readers were more rapid aural learners and slightly slower visual readers than the average readers. This discrepancy was most evident in the early phase of learning the list of word pairs and in the total trials required to obtain criterion.

96. Chan, A., & Travers, R. M. W. Sense modality switching and serial learning. *Perception and Psychophysics*, 1970, 8(1), 37-39.

This investigation examined the effect of sense modality switching of information at various positions of a serial learning task. Different numbers of flashes of light and different numbers of "blips" of a pure tone were used as signals in a four-position serial learning task. The design of the study involved a switch in sense modality at each one of the four possible positions in the series. Thus, it was possible to determine if the transmission of information through one sense modality makes it progressively more difficult or more time consuming to switch to another source of information transmitted through another modality. The results generally supported the contention that, as information is received through a particular modality, there is a build-up of the disruption involved in switching sense modality.

97. Dornbush, R. L., & Basow, S. The relationship between auditory and visual short-term memory and reading achievement. *Child Development*, 1970, 41, 1033-1044.

The relation between reading achievement and functioning in the auditory and visual modality was studied using short-term memory as an investigative tool. Memory spans in which rate of presentation, modality of presentation, and order of report were varied were presented to subjects in each of four grades: first, third, fifth, and ninth. Intelligence was held constant; subjects in each grade were subdivided according to reading ability--good and poor. It was found that performance on memory tasks was not affected by reading level and that young subjects do not operate in terms of storage; they ignore what they cannot immediately handle.

98. Gibson, E. J., & Yonas, A. A developmental study of the effects of visual and auditory interference on a visual scanning task. *Psychonomic Science*, 1966, 5, 163-164.

The effects of visual and auditory interference on a visual scanning task were compared with children from the third grade and college sophomores. A highly confusable visual context significantly reduced scanning rate for both children and adults, but a highly confusable auditory context, played over earphones, had no effect on either group. There was a significant age interaction with interfering visual context. It seems likely that theories assuming auditory encoding of visually presented graphic items have little predictive value for a scanning task.

99. Holloway, G. F. Auditory-visual integration in language-delayed children. *Journal of Learning Disabilities*, 1971, 4(4), 204-208.

Twelve language-delayed children with non-specific etiologies were matched with children having normal language development for age, sex, and IQ. Measurement of auditory-visual integrative ability, visual-motor integrative ability, and perception of distorted speech revealed the two groups to be significantly different in the auditory-visual component and perception of distorted speech, but not in visual-motor integrative ability.

100. Jensen, A. R. Individual differences in visual and auditory memory. *Journal of Educational Psychology*, 1971, 62(2), 123-131.

Two groups were given visual and auditory forms of a digit memory test in a counterbalanced order (auditory-visual group and visual-auditory group) under conditions of immediate and 10-second delayed recall. Two control groups were given exclusively either the visual or auditory test. Auditory memory was better than visual for immediate recall; the reverse was true for delayed recall, the interaction being significant beyond $p < .001$. The correlations between individual differences in auditory and visual memory, after correction for attenuation based on reliabilities obtained from the control groups, did not significantly differ from unity for either immediate or delayed recall. Thus there was no evidence for individual differences as a function of sensory modality of the input. On the other hand, there was a significant ($p < .001$) interaction between subjects and time of recall (immediate versus delayed).

101. Kahn, D., & Birch, H. G. Development of auditory-visual integration and reading achievement. *Perceptual and Motor Skills*, 1968, 27, 459-468.

The interrelationships among auditory-visual integrative competence, IQ, and type of reading task were studied in 350 elementary school age boys from Grades 2 through 6. Visual and auditory discrimination skills, auditory rote memory, and the application of verbal labels to the physical stimuli were examined as possible mediators of the relation of auditory-visual integration to reading. It was found that (a) auditory-visual integrative competence and reading achievement were positively associated at all grade levels; (b) when the effects of IQ were partialled out auditory-visual integration continued to be related to reading skill especially Word Knowledge; and (c) none of the variables postulated as mediators satisfactorily accounted for individual differences in auditory-visual integrative performance. The data are interpreted within a framework which attempts to resolve apparent differences among studies previously reported. Special consideration is given to the differential effects of partialling IQ on the relationship of auditory-visual competence to different aspects of the reading task and to the relative effectiveness of using verbal labels and other strategies for making auditory-visual integrative judgments.

102. Katz, P. A., & Deutsch, M. Relation of auditory-visual shifting to reading achievement. *Perceptual and Motor Skills*, 1963, 17, 327-332.

One perceptual skill which may underlie reading behavior is the ability to process sequentially presented auditory and visual information. The present study investigated the hypothesis that retarded and potentially retarded readers would exhibit difficulty in rapidly shifting attention between auditory and visual stimuli. Possible age differences in this behavior were also examined. Reaction times to a series of lights and sounds were obtained from normal and retarded readers at three grade levels. The findings indicated that at all ages poor and good readers differed significantly in the ease with which attention was shifted from one modality to another.

103. Katz, P. A., & Deutsch, M. The relationship of auditory and visual functioning to reading achievement in disadvantaged children. In Deutsch, M. (Ed.) *The disadvantaged child and the social milieu*, New York: Basic Books, 1967.

The present research attempted to obtain information about possible interrelationships among some of the visual and auditory functions which underlie reading behavior. ...The notion that defective auditory and/or visual functioning may play a role in producing reading retardation has been suggested by numberous investigators, and in recent years, there has been increased interest in studying the perceptual behavior of children who are retarded in reading.

Subjects were chosen from the first, third and fifth grade classes of two elementary schools in the Harlem area of New York City. (Note: lower class Negro males.) The technique used in the present investigation was an adaptation of the test described by Rosvold et al., 1956. Colors were employed as stimuli with the children, however, rather than letters which were used in the earlier study. There were three forms of the test: visual, auditory, and combined auditory-visual.

The result of major interest to the purpose of this study is the interaction between type of reaction time (i.e., ipsi- and cross-modal) and reading level. This interaction was signi- at the .01 level indicating that retarded readers exhibited greater difficulty than nornal readers in shifting from one modality to another. The mean increase from the ipsi- to the cross-modal condition for the retarded readers was approximately twice that for the high reader groups. Thus, the interaction supports the hypothesis that poor readers cannot shift attention between modalities as rapidly as normal readers...

In summary, these findings may be taken as evidence for the fact that poor and good readers differ in their ability to discriminate between pairs of linguistic stimuli presented in two modalities with two degrees of meaningfulness. The differences were most pronounced at the younger age levels.

Intelligence appears to be related to both auditory and visual discrimination at the three grade levels.

The most significant finding to emerge from this project was the consistency with which the various auditory and visual measures differentiated good from poor readers.

104. Kling, M. Some relationships between auditory and visual discriminations. *California Journal of Education*, 1968, XIX(4), 170-181.

Auditory and visual sensitivity have been suggested as accounting for individual differences in efficiency of learning. The purposes of this study were: 1) to construct an auditory and discrimination test. 2) To study some relationships between auditory and visual discrimination. The significance of this study lies in its attempt to formulate and provide a method for comparing responses to changes in auditory and visual stimuli.

Auditory and Visual Discrimination Tests were administered to 66 students in an introductory course in Educational Psychology. Altogether there were 42 women and 24 men.

The Pearson r between the Auditory and Visual Discrimination Test for the 66 subjects is .03. Since this correlation is negligible, it may be concluded that each test is measuring independent abilities. All the correlations were low and not statistically significant. Consequently, it does not seem that extreme visual and auditory discrimination abilities, as measured by the tests used in this study, are correlated.

The experimental results of this study lend support to the contention expressed in Holmes' *Substrata factor of reading* that the individual differences in the sensory modes are not necessarily highly correlated. It further suggests that if, as is indicated by Ryan in "interrelations of the sensory systems in perception," by Gilbert in "intersensory facilitation and injabotopm," by Harris in "Some relations between vision and audition," and by Stevens in "decibels of light and sound," work, that there exists an "intersensory facilitation;" such facilitation is probably not at the level of elementary perception, but on the somewhat higher level of cerebral association.

105. LaBerge, D. On the processing of simple visual and auditory stimuli at distinct levels. *Perception and Psychophysics*, 1971, 9(4), 331-334.

Two reaction time studies explored the possibility that identification of a single stimulus can take place through more than one perceptual route. In the first experiment, mean reaction time to color was systematically changed by varying type of catch stimulus. In the second experiment, the form of the reaction time distribution to a tone was changed by varying type of catch stimulus. Considerations of distribution means and shapes led to the conclusion that detection and discrimination are two of the alternative levels of perceptual processing which can be evoked in rapid identification of these stimuli.

106. Levy, B. A. Role of articulation in auditory and visual short-term memory. *Journal of Verbal Learning and Verbal Behaivor*, 1971, 10, 123-132.

Two studies are reported which investigated the role of overt articulatory activity in the processing of visually and auditorily presented material. The results of Experiment I showed that letters which were either heard or articulated could be recalled from short-term memory (STM) while visually presented items, neither articulated nor heard, were recalled close to the chance level. Experiment II was a replication of Experiment I but using both recall and recognition measures and words rather than letters. Words were used so that the retention of the semantic and associative features could be measured. The results again suggested the use of both acoustic and articulatory features in STM while semantic and visual features appeared to play little role in retrieval from STM.

107. Parkinson, S. R., Parks, T. E., & Kroll, N. E. A. Visual and auditory short-term memory: Effects of phonemically similar auditory shadow material during the retention interval. *Journal of Experimental Psychology*, 1971, 87(2), 274-280.

A series of three experiments investigated human ability to retain a single letter of the alphabet (presented either visually or aurally) while concurrently shadowing (repeating aloud) a series of aurally presented letters. The retention of auditory letters was adversely affected when the shadow list contained phonemically similar letters. On the other hand, retention of visually presented letters suffered when subsequent shadow letters all contained the root vowel, $\bar{e}$, whether or not the memory letter itself had that root vowel. Thus, the hypothesis that visual presentation led to only an auditory form of storage was not supported. Alternatively, it was concluded that visual stimuli may lead to retention of the appearance of, rather than the name of, each letter and that these memories may persist for at least several seconds.

108. Pick, H. L., Jr., Pick, A. D., & Klein, R. E. Perceptual integration in children. In Lipsett, L. P., & Spiker, C. C. (Eds.), *Advances in child development and behavior.* New York: Academic Press, 1967. Volume 3. Pp. 192-220.

Our focus is upon methodological problems in the study of intermodal integration, gaps in present knowledge, and possible substantive generalizations or hypotheses.

From a methodological point of view, there is potential usefulness of intra-intermodal experimental designs and sighted-blind comparison. Presently available data, however, using the intra-intermodal design are not always consistent from one investigator to another but this is probably due to procedural differences rather than a weakness of the design. The importance of the dependent variable in a number of contexts cannot be overlooked and viewing the phenomena as possible intermodal tasks emphasizes the importance of the response modality.

Some substantitive generalities about intermodal integration are possible. It is safe to say that some forms of intermodal coordination appear quite early in development. Ability to localize, for example, as manifested in various coordinations between eye, ear, and hand achieves precision at an early age. There is ample evidence that the development of perceptual process in the various sense modalities is not parallel even when the same stimulus discriminations are required. For example, different aspects of shape discrimination develop at different rates in vision and touch. And there is much evidence refuting the classical doctrine that touch teaches vision. This includes evidence of (1) the earlier development of visual discrimination as compared with tactual and (2) the dominance of visual information over tactual in sensory conflict situations.

In concluding, a theoretical thread which appears in several instances and offers a general hypothesis is that simple and higher order stimulus dimensions relate to different intermodal processes. The integration of simple dimensions reflects modality specific processes while the integration of higher order stimuli reflects more central processes common to the several modalities.

109. Postman, L., & Rosenzweig, M. R. Practice and transfer in the visual and auditory recognition of verbal stimuli. *American Journal of Psychology*, 1956, 69, 209-226.

This experiment investigates the effects of preliminary training on the visual and auditory discrimination of verbal stimuli. A series of nonsense-syllables was selected for initial ease of visual and auditory discrimination. Different syllables were then given varying frequencies of exercise, ranging from 0 to 15 repetitions. Half the subjects received visual training; the other half were given auditory training. Following the training, recognition was tested. The test-series included the experimental syllables as well as English words. For half the subjects trained visually, the recognition-test was visual, while for the other half the test was auditory. Similarly, auditory training was followed either by a visual or by an auditory test. For visual recognition, the test-items were presented tachistoscopically under different intensities of illumination. For the auditory test, the items were presented in conjunction with different degrees of masking noise.

Frequency of past exercise was found to be a significant determinant of both visual and auditory recognition. The effects were more clear-cut in auditory than in visual discrimination. When the same sense-modality was involved in both training and test, the effects of practice were more pronounced than when there was a change in modality. The transfer-effects from visual training to auditory discrimination were more pronounced than conversely. The analysis of results stressed the reduction of alternative responses produced by the preliminary training. Auditory stimulation tended to produce more complete responses than did visual stimulation. The auditory test was more sensitive than the visual test to the reduction in the number of alternative responses resulting from the preliminary training.

110. Rubinstein, L., & Gruenberg. E. M. Intramodal and crossmodal sensory transfer of visual and auditory temporal patterns. *Perception and Psychophysics*, 1971, 9(5), 385-390.

Temporal pattern perception for vision and audition was measured using pair comparisons of precisely determined rhythms as test items. Visual rhythms were more difficult to match than were comparable auditory ones. Crossmodal transfer equaled intramodal transfer in one experiment but was inferior in another. The differences between intra- and crossmodal transfer were related to the frequency of pattern elements, with crossmodal performance decreasing more when frequency rose. The nine test items showed a consistency in relative difficulty across experimental conditions. Differences in item difficulty were related to the symmetry of the first pattern in the item.

111. Sidman, M. Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research*, 1971, 14, 5-13.

A retarded boy, unable to read printed words orally or with comprehension, could match spoken words to pictures and could name pictures. After being taught to match spoken to printed words, he was then capable of reading comprehension (matching the printed words to pictures) and oral reading (naming the printed words aloud).

112. Sterritt, G. M., & Rudnick, M. Auditory and visual rhythm perception in relation to reading ability in fourth grade boys. *Perceptual and Motor Skills*, 1966, 22, 859-864.

Formal language is typically first learned in the form of an auditory-temporal code. Learning to read ordinarily consists of learning to translate this auditory temporal code into one that is visually and spatially organized. Thus, learning to read seems to be dependent, to some degree, on the ability to transpose between auditory-temporal and visual spatial codes.

The research reported here employed three tests with 36 boys in the fourth grade of a middle-class suburban public school. In one test, rhythms were tapped out by a pencil that could be seen and heard, while another test employed purely auditory stimuli, and the third used purely visual stimuli to form the temporal patterns. In each test the child's task was to attend to the temporal rhythm and then select one which had been seen or heard. In contrast to the pencil tapping test, the auditory stimulus test required transposition from audition to vision, while the visual test clearly eliminated the factor of auditory-visual transposition. The multiple regression approach was employed to assess the role of intelligence in the relationship of each test to reading.

The results showed auditory-temporal rhythm perception or the ability to transpose from auditory-temporal to visual-spatial patterns is related to reading in fourth-grade boys in a way that is not fully accounted for by general intelligence.

113. Suedfeld, P., Tomkins, S. S., & Tucker, W. H. On relations among perceptual and cognitive measures of information processing. *Perception and Psychophysics*, 1969, 6(1), 45-46.

Tests of visual information processing and verbal information processing were administered to 178 subjects. Intercorrelations showed low positive relationships between two sets of two cognitive measures each: the Sentence Completion Test (Schroder, Driver, & Streufert, 1967) and the Interpersonal Topical Inventory (Tuckman, 1965), and the Interpersonal Topical Inventory and the Polarity Scale (1965) and a high negative correlation between preference for highly complex and for moderately complex visual stimuli. Factor analysis showed three reliable major factors. While there are some known relationships between perceptual and cognitive characteristics, the research here indicates no general correspondence between visual and cognitive behavior realms has yet been established. Until such a bridge is built theorists will find it difficult to formulate a unitary concept of information processing.

114. Wepman, J. M. Auditory discrimination, speech, and reading. *Elementary School Journal*, March, 1960, 325-333.

The data reported in this paper are interpreted as showing that a close relationship exists between auditory discrimination and speech accuracy of articulation. They also show a relationship of importance between poor reading achievement and the auditory discrimination ability.

Children with poor articulation at the early school age are likely to be those with poor auditory discrimination. Many of these children will develop better discrimination during their first two years in school, without therapy. When they reach the age of eight years or thereabouts if they still show poor articulation they should receive training.

The important thing seems to be the early recognition of the problem and the effect that later developing auditory discrimination may have on a child's speech and reading. There is a real need to implement the training of such children by maximizing their better-developed modalities of learning (sight reading for those with poor discrimination, phonics for those with good discrimination) until their developmental processes come into balance.

It is the argument of the writer that both from clinical experience and from data such as is here reported, children should be studied as they reach school age to determine whether their auditory abilities have reached the level of maturation where they can benefit from phonic instruction in reading or from auditory training in speech. Unless this is done, we will continue to make the error of approaching all children as though they can learn equally well through the same modality. The need to individualize instruction, at least to the point of grouping visual learners and auditory learners separately at the onset of reading instruction, seems an obvious way to minimize the problem.

115. Wolff, P., & Wilder, L. Visual and auditory memory in children. Unpublished manuscript, University of Wisconsin, no date available.

Three studies investigated the effects of experimenter-produced labels on children's serial position memory. As in previous research with subject-produced labels, addition of the label facilitated performance only for the recency portion of the list. This effect did not vary systematically with age. Memory for the first serial position improved markedly between the ages of 5 1/2 to 6 1/2. Labels alone were superior to pictures at the end of the list, but pictures were superior to labels at the beginning. Combined picture and label presentation appeared to follow the curve for pictures at the beginning of the list and that for labels at the end. The results are discussed in terms of modality and mediation effects in children's short-term memory.

BLENDING

116. Balmuth, M. The relationship between phoneme blending of nonsense syllables and silent reading achievement among elementary school children. Unpublished doctoral dissertation, New York University, 1966.

An original test, entitled "Experimental Test of Phoneme Blending" (or ETPB), was devised to measure phoneme blending of nonsense syllables. Reliability and validity for this test were partially established. The final form of the ETPB was then administered to 252 boys and girls, randomly selected from grades one through six in equal numbers of twenty-one boys and twenty-one girls from each grade. Preliminary screening was done to ascertain that the subjects had normal hearing levels. The Metropolitan Achievement Test, silent reading subtest, was administered to the 210 children in the sample who were in grades two through six.

Additionally, the variables of age, sex, and ethnic origin were examined in relation to phoneme blending of nonsense syllables. The results of the study all support the basic hypotheses. The major conclusions of this study were: phoneme blending of nonsense syllables can be reliably and validly measured; there is a positive relationship between phoneme blending of nonsense syllables and silent reading achievement among elementary school children and this relationship is not affected by the child's sex. In addition, it was concluded that, while a child's sex will not affect his phoneme blending of nonsense syllables, older children are better blenders of nonsense syllables than are younger children, and New York City children of European ethnic origin are better blenders of nonsense syllables than are New York City children of Negro or Latin American ethnic origin.

In summarizing the factors involved in phoneme blending difficulty, the factors cannot be listed in order of importance since the relative difficulty of a given blended item will be affected differently by any given factor, depending upon the forms and combinations of all the factors in that item. The factors involved are: (a) the number of pauses, (b) the position of each phoneme in relation to the total syllable, (c) the position of each phoneme in relation to the other phonemes in the syllable, (d) the number of phonemes that must be presented as parts of brief syllables, and (e) the inherent discriminability of the individual phonemes.

117. Bishop, C. H. Transfer effects of word and letter training in reading. *Journal of Verbal Learning and Verbal Behavior*, 1964, 3, 215-221.

The child's process of learning to read was simulated by teaching adults to read several Arabic words. The purposes of the study were to determine the transfer value of training with individual letters as opposed to whole words, and to investigate the role of grapheme-phoneme associations in reading. It was found that letter training had greater transfer value than word training. Knowledge of grapheme-phoneme correspondences was not necessary to read words, but was necessary for transfer to new words. The reason for the overall inferiority of word training was either that it did not direct as many subjects to learn grapheme-phoneme correspondences, or that not all subjects were capable of picking out these relationships when embedded in words.

Note: When interpreting the results which Bishop obtained, it is important to keep in mind three factors which limit generalizations from her data. First, she used adults rather than children for experimental subjects. Second, her stimuli words were Arabic rather than English words. Third, unlike English, the Arabic language has a one-to-one grapheme-phoneme relationship.

118. Bridge, J. T. Rank-ordering of letters and letter combinations according to ease of learning their sound associations. Master's Thesis, University of Texas at El Paso, 1968. (Cited by P. Desberg in *Sound blending: The relationship of inter-letter interval, consonant category, and stimulus word frequency to word identification*. Unpublished doctoral dissertation, University of Southern California, 1969. P. 10.)

Bridge using a paired-associate task determined an "ease of learning" hierarchy for 35 letters and letter combinations. The 35 letter units were paired with the sound most commonly associated with each. Kindergarten subjects were used to scale the letters. The experiment was divided into six phases: (1) subjects learned seven sets of five letters until all 35 letter units were mastered, (2) subjects were presented with five sets of seven letters, (3) nine letter-units per set, (4) 12 letter-units per set, (5) 18 letter-units per set, (6) all 35 letter-units in a set. The mean number of errors over the six phases was used to rank order the letter units. Bridge arrived at the following conclusions:

1. There is a difference in learnability between letter-sound associations. Furthermore, there is considerable agreement among children as to which are easy and which are difficult.

2. There was no significant correlation between learning and frequency of occurrence of the phoneme nor between learning and ease of reproducing the phoneme in a word.

3. Manner of articulation affects learning.

4. Some form of meaningfulness is inextricably entwined with manner of articulation.

5. Continuants were the easiest sounds to learn.

6. Short vowels were more difficult to learn than offglides.

119. Brown, L. Auditory blending ability as perceptual process, and its relationship to beginning reading success. Master's Thesis, Bank Street College of Education, 1964.

Brown gave the "Draw-a-man Test," a measure of maturity, to her kindergarten and first grade children. She found that the results of the test differentiated good blenders from poor blenders more than it differentiated good readers from poor readers. Brown concluded that the added maturation which occurs with increased age may be involved in the development of the capacity to perform a blending task.*

120. Chall, J., Roswell, F. G., & Blumenthal, S. H. Auditory blending ability: A factor in success in beginning reading. *Reading Teacher*, 1963, 113-118.

This report is part of a longitudinal study of factors which make for success in beginning reading. We became interested in auditory blending ability after noting that children with severe reading disabilities also had extreme difficulty in learning phonics, particularly in blending and synthesizing sounds. Auditory blending, as we have defined it, involves the ability to reproduce a word by synthesizing its component sounds.

Our study explores the relation between auditory blending ability, reading achievement, and I.Q. The subjects were 62 Negro children in two first grade classes in New York City public schools. Our data was derived from record card information and individual testing sessions. The two senior authors constructed a 30 item test of auditory blending ability which was given in grade 1, grade 2 or 3 and again in grade 4. The major findings were:

1. Auditory blending ability, whether tested in first grade, second-third, or fourth grades, is positively correlated with oral and silent reading ability through the fourth grade.

2. Auditory blending ability in the first grade maintains substantially the same relationship with all fourth grade measures, whether oral, silent, or word analysis skills.

3. Auditory blending in grades 2-3 and grade 4 also maintains substantially the same relation with oral reading and word analysis skills in the third and fourth grades, compared to auditory blending in grade 1.

4. While auditory blending in grade 1 is not correlated with I.Q., it appears to be so in grades 2-3 and grade 4.

It appears that blending ability has a substantial relationship to reading achievement, especially to word recognition and analysis. Poor auditory blending may signify a defect or a lag in neurophysiological development. The relation between I.Q. and auditory blending is not clear and needs further study.

Note: Three aspects of the Chall, Roswell, and Blumenthal study should be carefully considered in evaluating their results. First, their subjects were Black first graders in New York. Research studies have indicated that the phonological system of Black speakers differs from the phonological system of standard English. Second, the words used in segmented form by the experimenter had pronunciation changes due to utilization in isolation. Third, during the experimental conditions, the subjects could see the experimenters lips when he uttered. This might have served as a substantial articulatory cue.

121. Chapman, R. S. Report from the project on basic prereading skills: Identification and improvement. Technical Report, March, 1971, Wisconsin Research and Development Center for Cognitive Learning, Madison, Wisconsin.

This report summarizes the findings of a February 1971 administration to 138 kindergartners of a revised and expanded version of the Wisconsin Basic Prereading Skill Test. The test battery being developed has two purposes: a) the identification of prereading skill deficits in kindergarteners for individualized curriculum planning and b) the prediction of reading achievement at the end of first grade.

Included in the February test battery were visual tests for attending to letter orientation, letter string order, and letter string detail; auditory tests for sound matching and sound blending; learning rate tests for picture-sound association and word segmentation; and a letter naming test included only for background information. Data were gathered on two forms of each visual test by testing a child on the complete test battery one day and the alternate forms of the visual tests the preceding or following day.

Pearson product-moment correlations for auditory, learning, and Letter Naming Tests were calculated. The results showed that sound matching and sound blending do not correlate significantly with one another, suggesting that the attempt to isolate independent auditory skills has been successful. Sound matching, but not sound blending, correlates significantly with Letter Naming. The relation of each to first grade reading achievement must be further demonstrated in multiple regression analyses of longitudinal data to be gathered in Spring 1972.

122. Coleman, E. B. Collecting a data base for a reading technology. *Journal of Educational Psychology, Monograph*, 1970, 61(4), 1-23.

A research strategy for educational engineering is outlined. Before any great amount of engineering is possible, scientific knowledge must be transformed into tables of useful measures, and the relation of education to its underlying sciences requires that the transforming be by experiment. Most of the basic research that generated knowledge of interest to education was performed on rats or college sophomores, and there are no mathematical operations for transforming such knowledge into useful tables. The experiments themselves must be replicated on relevant populations and materials. Four transforming experiments were performed. They gave tables that scale the common words for learnability, the graphemes for ease of learning their sounds, the English sounds for phonic blendability, the letters for ease of printing.

Unpublished data are presented on blending skills based on research by Laumbach (1968), Bridge (1968), and Jones (1968). Laumbach made two methodological findings of importance. She found evidence that the major determinant of phonic blendability was phonological. In other words, the blendability of a given word was not a function of the words frequency of usage, but instead almost totally governed by the properties of the individual sounds. Second, blending ability manifested itself as a concept induction task and not as a paired-associate learning task. Her data furter indicated that CV is more difficult to blend than VC; that VC ending in voiced sound was more difficult than that ending in an unvoiced sound; and that for the CV syllables, it was more difficult with rounding off-glide (e.g., W) than with those ending in a front off-glide (e.g., Y). Coleman's conclusions from blending studies were that (1) Laumbach, Bridge, and Jones obtained similar findings, (2) large differences--as high as 10 to 1--in the blendability of different phoneme combinations exist, and (3) most children are similar and show specific phoneme blending abilities and difficulties congruent with the information presented here.*

123. Desberg, P. Blending: Preliminary analysis and literature review. Research Memorandum, June 5, 1969, Southwest Regional Laboratory, Inglewood, California. (a)

In the act of reading, one does not proceed directly from print to meaning. There is an intermediate stage in which a set of decoding skills is used to enable the reader to identify his spoken words in printed form. The initial stages of reading instruction are concerned primarily with the student's acquisition of these word identification skills. However, as instruction progresses the emphasis is transferred to comprehension skills. The identification phase of reading has been represented as a series of four chronologically related stages (Desberg & Berdiansky, 1968): Discrimination, Blending, Phonics Rules, and Residual. The first stage of this conceptualization involves discrimination learning. This is the visual and auditory differentiation of letters, and ultimately results in the association of letter-sound correspondences.

Blending, the subject of this paper, is the production of a word or syllable through synthesis of its component sounds (this definition is introductory and will be explained later in the paper). Phonics rules refer to a set of higher-order correspondence rules that describe, more throughly, the relationship of English orthography to English pronunciation. The residual stage refers to the instruction of low frequency phonics rules, regular but complex rules (e.g., morpho-phonemic shifts, etc.), and idiosyncratic rules.

124. Desberg, P. Sound blending: The relationship of inter-letter interval, consonant category, and stimulus word frequency to word identification. Unpublished doctoral dissertation, University of Southern California, 1969. (b)

Sixty subjects were randomly divided into four groups, on the basis of stimulus words received: high frequency stops (group 1), low frequency stops (group 2), high frequency continuants (group 3), and low frequency continuants (group 4). Each subject received the stimulus word separated at five inter-letter intervals (0, 0.5, 1.0, 1.5, and 2.0 sec.).

Consonant category referred to a division based upon initial consonants. The following consonants were designed as stops: /p t k b c g č ǰ/. The continuant consonants were /f v s z s m n l r θ w/. Stimulus words were also divided into two frequency levels (high and low) based upon the G count of the Thorndike-Lorge word count. Each stimulus word was recorded on an individual tape loop at each inter-letter interval.

Significant differences in the number of correct word identifications were attributable to the factor of inter-letter interval length. These differences were only found in comparisons involving the 0.0 second group. When this level was deleted, the data were re-analyzed, there were no differences attributable to inter-letter interval length. Based upon these results, stage 2 was deleted from the model.

Words beginning with stop consonants were identified correctly more often than words beginning with continuant consonants. There were no significant interactions between consonant category and inter-letter interval. An experiment designed to investigate the relative importance of consonant category to blending and word identification was proposed.

High frequency stimulus words were identified correctly more often than low frequency words, however, interactions predicted between stimulus word frequency and the other two factors were not found.

125. Fries, C. *Linguistics and reading.* New York: Holt, Rinehart, and Winston, 1963.

Fries states: Our approach does rest upon *the relation between the sound patterns of the words and the letter symbols of our alphabet* but this relation is *not* such as to lead us to seek to match specific letters with each of the physical "sounds" of our language. Nor does it assume that the pronunciation of a word is a *fusion* or *blending* of the sounds represented by the individual letters by which the word is spelled. The relation of the sound patterns of the "words" to the letter symbols of our alphabet is *not a one-for-one correspondence between the isolated individual letters of the spelling and specific separate phonetic features of the sound pattern.* The "phonics" approach of (a) isolating and in many instances trying to pronounce the individual "sounds" of a word, and (b) seeking to learn the "sounds each letter makes" has had some merit, for it serves to turn attention to the fact that our language sounds and alphabet spellings are indeed related. Because of that fact, "phonics," in spite of all the critical discussion and all the evidence brought against its assumptions and practices, has persisted. (p. 146.)

126. Gates, A. I., & Bond, G. L. Reading readiness: A study of factors determining success and failure in beginning reading. *Teachers College Record*, 1936, 37, 679-685.

Gates and Bond attempted to investigate reading readiness as it correlated with various other skills. They reported that there were "fair" correlations between the readiness skills of word-pairs discrimination, reproduction of letter sounds and nonsense words, and giving letters for sounds, and subsequent success in beginning reading. Their results further led them to conclude that tests of blending and rhyming abilities did not discriminate between children who were successful or unsuccessful in the reading task.*

127. Gates, A. I., Bond, G. L., & Russell, D. H. *Methods of determining reading readiness*. New York: Teachers College, Columbia University, 1939.

In a research study beginning in 1934, Gates, Bond, and Russell investigated a multitude of methods of appraising reading readiness, including a number of auditory discrimination tasks. They computed the correlations between each of the auditory tasks and reading achievement along with other hypothesized reading skill tasks. The population was four New York City public school first-grade classes and the measures were compiled three times; mid-first-grade; end of first-grade; and mid-second-grade. The man correlation coefficients were computed to give some indication of the relationship between each instrument and general reading ability. The average correlations they obtained were:

1. giving words with the same or rhyming final sounds .43.
2. giving words with stated initial sounds -.41.
   (score was the number of errors)
3. blending .38.
4. reproduction of nonsense words .23.
5. giving letters for sounds .21.
6. discriminating word-pairs .20.*

128. Gibson, E. J., Bishop, C. H., Schiff, W., & Smith, J. Comparison of meaningfulness and pronounciability as grouping principles in the perception and retention of verbal materials. *Journal of Experimental Psychology*, 1964, 67, 173-182.

Thresholds of visual perception and two measures of retention were obtained for trigrams varying in pronunciability and meaningfulness (semantic reference of the kind found in well-known initials), and for control items. The three types of trigrams contained the same letters rearranged anagram-wise. Perceptual thresholds were lowest for pronounceable items, and next lowest for meaningful ones. On the other hand retention, measured by both recognition and free recall, was best for the meaningful items and second best for pronounceable ones. Pronunciability was inferred to be the better grouping principle for reading or coding to speech units. Meaningfulness was inferred to have facilitated retention more than pronunciabililty by providing a category for grouping the initial items, thus aiding retrieval.

Note: As Desberg (1969) points out, the Gibson et al. research demonstrates that the skilled reader utilizes letter groups which follow the phonotactic rules of English as their reading unit more easily than unpronounceable trigrams which do not follow the phonotactic rules of English.

129. Gibson, E. J., Pick, A., Osser, H., & Hammond, N. The role of grapheme-phoneme correspondences in the perception of words. *American Journal of Psychology*, 1962, 75, 554-570.

The hypothesis has been proposed that the proper unit of the reading process is neither the single letter nor the whole word but a higher-order invariant derived from grapheme-phoneme correspondences. Rules can be drawn up for predicting spelling from sound if temporal patterning of "clusters" is taken into account. It was proposed that the skilled reader has learned to perceive as units the letter-patterns conforming to these rules and that such patterns have, therefore, an advantage in reading.

Several experiments were performed to test this hypothesis. Pseudo-words conforming to rules of spelling-to-sound correlation were compared with ones of low correlation under conditions of tachistoscopic viewing.

In the first experiment, it was found that the subjects reproduce pseudo-words of high correlation more accurately than ones matched for summed letter frequency, but of low correlation.

In a second experiment, comparable results were obtained when the subjects were not asked to reproduce a word, but performed perceptual matching of the word exposed tachistoscopically with a member of a multiple-choice list. It was concluded that the perceptual process has been facilitated in skilled readers for units discovered during long exposures to the grapheme-phoneme correspondences of the English language.

Reading consists of decoding graphic material to the phonemic patterns of spoken language which have already been mastered when reading is begun. The units to be decoded are not single letters, for these have no invariant acoustic match in our language.

130. Gotkin, L. G., McSweeney, J. F., & Richardson, E. The development of a beginning reading program: An empirically derived sequenced for the acquisition of analytical skills, 1969. ERIC ED 038 239.

A three-year Harlem project in which 5-year-olds from socially disadvantaged backgrounds were taught an interrelated hierarchy of beginning reading skills utilizing the Edison Responsive Environments instrument (talking typewriter) was reported. The emphasis was on development of instructional, behavioral, and motivational strategies. Reading skills are presented in detail as behavioral objectives and programming paradigms related to teaching these skills are described.

The "sounding out" or blending skill of phonetically regular 3-letter words is a complex task involving several distinct component behaviors. We concluded that in order to blend the sounds represented in a trigram, the child must make an ordered oral synthesis of the sounds represented by the letters in the whole word. What is required is a left to right movement of the eyes together with a left to right oral mixing of the individual sounds. The separate subskills which were taught to the children in order to accomplish these tasks are divided into three main categories of training: (1) oral sound-symbol correspondence of individual letters, (2) letter order, and (3) the perceptual set. The perceptual set was taught by training the child to perceive a 3-letter word as made up of two parts, i.e., the first two letters and the last letter.

...Once a child had analyzed a 3-letter word, using his knowledge of the letter sounds in conjunction with the perceptual set, into two units (pa t), he then faced the task of synthesizing (mixing or blending) these two units together to say the whole-word sound (pat).

In the transfer test the children were presented with seven new trigrams. These trigrams were composed of familiar letters and bigram combinations taught in the program but were unfamiliar (not taught in the program in their whole word [trigram] structure).

...The transfer test required each child to produce three distinct sounds for each of seven trigrams: two analytical sounds (first two letters, last letter), and one synthesis (whole word). These three sounds were considered as one response chain for each trigram. The response chains were analyzed for 33 first grade children and 15 kindergarten children. The 33 first graders could produce a maximum of 231 analytical and synthesizing response chains (7 x 33), while the 15 kindergarten children could produce 105 response chains (7 x 15).

The distribution of responses are almost identical for both kindergarten and first grade. While only about 30% of the first grade responses and about 30% of the kindergarten responses revealed correct synthesis, more than 90% of the responses for each sample yield evidence of correct analysis.

A retention test, identical to the criterion test, was administered to fifteen of the experimental kindergarten children after a delay period ranging from twenty to ninety-eight days after completion of the program... Retention was greater for single sounds than for higher blending skills. Within the blending skills retention was greater for bigrams than for trigrams, but both bigram and trigram blending showed a similar retention level of about 68% as opposed to 90% of single sounds.

Of the 33 first graders, only one child scored below 85% mastery level on the posttest, while 32 recorded 100% mastery. The transfer test scores for the first graders are similar to those for the kindergarten population. Nine children displayed no transfer evidence, while the remaining 24 displayed evidence of abstract blending for three nonsense trigrams.

131. Huset, M. Relationship between difficulty in auditory blending and some diagnostic indicators of organicity in children of average or superior intelligence with reading disability. Master's Thesis, The City College, New York, June 1961.

Huset used two groups of third to fifth grade children with normal to above normal intelligence quotients. She measured blending ability, perceptual skills, motor skills, and analytic-synthetic ability. Her results showed that children with poor blending ability were significantly poorer on tests which involved analytic-synthetic ability. In addition, these same children also showed poorer perceptual and motor skills. She concluded that "children who had severe reading ability and auditory blending difficulty were more likely to have basic and pervasive neurological involvement."*

132. Jeffrey, W. E., & Samuels, S. J. Effect of method of reading training on initial learning and transfer. *Journal of Verbal Learning and Verbal Behavior*, 1967, 6, 354-358.

Letter (phonic) and word (look-say) methods of reading training were compared with regard to transfer of training to new words. The graphemes were completely novel although the phonemes and words were familiar. The letter-training group was superior to the word-training group on the initial transfer trial as well as on a learning performance measure. Intelligence proved to be a significant variable in transfer but not in initial training.

It is important to emphasize that letter training by itself probably would not have produced the distinctive results that it did, had it not been coupled with phonic blend training in stage 1. ...This emphasizes the importance of an analysis of the criterion task into its components, and the necessity of giving the subjects training in all the skills necessary for the successful execution of the criterion task.

133. Koehler, J., Jr. Novel word decoding in kindergarteners as a function of decoding strategy and segmentation-blending training form. Summary of 1972 AERA Report, Southwest Regional Laboratory, Inglewood, California.

An investigation of how segmentation-blending (SB) training form affects the application of decoding strategy (WD) to novel word decoding was conducted on kindergartners. Combinations of 2 WD strategies and 6 SB forms were applied to 12 groups of 6 children. The word decoding data indicated that the strategy involving C-VC and CC-VC elements for CVC and CCVC words transferred best with sounding out training, whereas this SB form was no better than one involving both blending and element identification for the strategy having CV-C and C-CVC elements. Implications of these and other results for phonics reading instruction are examined.

134. Laumbach, J. D. Rank-ordering two-sound words as to phonic blendability. Master's Thesis, University of Texas at El Paso, 1968. Cited by P. Desberg, Sound blending: The relationship of inter-letter interval, consonant category, and stimulus word frequency to word identification. Unpublished doctoral dissertation, University of Southern California, 1969. P. 9.

Laumbach presented data that rank ordered 293 two-sound words according to blending difficulty. Children between the ages of 66 and 75 months served as subjects. In the experiment the experimenter pronounced the two sounds of each syllable and asked subject to pronounce the word that they formed. Each subject received about 600 presentations over several days of testing. The following conclusions were reported: (a) CV syllables were more difficult than VC, (b) VC syllables ending in a voiced consonant were more difficult than those ending in a voiceless consonant, (c) short vowel sounds were more difficult than glides, (d) for CV syllables, vowels ending in a round offglide were more difficult than vowels ending in a fronting offglide /y/. According to Laumbach, the experimental task was a concept induction problem rather than one of simple paired associate learning.

135. Marsh, G., & Sherman, M. Transfer from word components to words and vice versa in beginning reading. Technical Report No. 23, March 31, 1970, Southwest Regional Laboratory, Inglewood, California.

A major problem in the early stages of a phonics-emphasis reading program is to get the child to transfer grapheme-phoneme correspondences learned in one context to other similar situations. This study investigates the transfer relationships between three tasks which are used in the SWRL First-Year Communication Skills Program to help the child recognize the relationship between isolated letter sounds and the same sounds embedded in a word context. These tasks are: a) learning isolated letter sounds, b) learning sounded-out (phonemically segmented) words, and c) learning whole words. The literature suggests children apparently need explicit training on the letter-sound correspondences in order to show the appropriate transfer behavior.

The subjects were 96 children attending prekindergarten and kindergarten sessions. The children ranged in age from 4 years, 11 months to 6 years with a mean age of 5 years, 5 months. There were 51 boys and 45 girls.

The results of the present study rank the degree of transfer to be expected between words and word components tested. The greatest amount of transfer was obtained between isolated letter sounds and sounded-out words. The subjects in these two groups apparently picked up the principle that each grapheme is associated with a single phoneme and the spatial order of grapheme from left to right corresponds to the temporal order of phonemes.

The next largest amount of transfer was obtained between sounded-out words and whole words. In order for transfer of this type to occur, the child must recognize the sound of an isolated phoneme when it is embedded in a word context.

Finally, little if any positive transfer was obtained between isolated letter sounds and words or vice versa. The present results differ somewhat from those of previous studies.

Note: Bishop (1964) found in his research that there was a greater amount of transfer from words to letters than vice versa. Jeffrey and Samuels (1967) discovered from their research that there was greater transfer from letters to words. In the former case, the difference in findings from the Marsh and Sherman study may be attributable to two factors. First, Bishop used adult subjects and second, he required a syllabic rather than phonemic response from the subject. In the latter case, the difference in findings from the Marsh and Sherman study may be explained by the previous training of the Jeffrey and Samuels subjects on sounding-out and blending transfer list items.

136. Richardson, E., & Collier, L. Programmed tutoring of decoding skills with third and fifth grade non-readers. *Journal of Experimental Education*, 1971, 39(3), 56-64.

The acquisition of decoding skills (sound-symbol correspondence, visual analysis, and blending) was studied with twelve subjects who scored below average on a battery of psychomotor tests. A group of twelve "no treatment" control subjects were shown to be superior to the experimental subjects in reading simple sight words on a laboratory pretes[illegible] Each experimental subject required an average of 4.5 hours of tutorial time, distriguted across forty-three sessions, in learning the program content. Posttest results showed the experimental subjects to be superior to the controls on all measures of decoding and demonstrated that experimental subjects could apply decoding skills to unfamiliar content. The major conclusion drawn is that so-called dyslexic children can learn basic reading skills. The success was attributed to the highly-structured, programmed approach.

Another interesting insight into the blending skill is provided by the evidence that it is applied differentially to meaningful and nonsense words. On the one hand, it is clear that the skill led to the successful decoding of a greater percentage of novel meaningful words than nonsense words. On the other hand, when the visual analysis was a required part of the response, there was a greater increase in the percentage of nonsense words correctly decoded than meaningful words. One possible interpretation of these results is that children were using their blending skills when simply asked to read the word (the look-say response) but were more successful in applying it to words already in their vocabulary (meaningful). However, being specifically instructed to analyze the words orally (blended response) significantly increased the number of words they could decode for both categories. It would follow, then that there would be a greater increase for the nonsense words since several of the meaningful words had already been successfully blended when the look-say response was required.

137. Silberman, H. F. Empirical development on a beginning reading skill. *Project Literacy Report No. 4*, Systems Development Corporation, Santa Monica, California, 1964. (Cited by P. Desberg in *Sound blending: The relationship of inter-letter interval, consonant category, and stimulus word frequency to word identification.* Unpublished doctoral dissertation, University of Southern California, 1969. P. 7.)

Silberman developed a reading program designed to instruct children to blend initial consonants and VC syllables. His instructional procedure used consonant-by-VC syllable design (e.g., r + at; p + it; b + an). Silberman found that children do not necessarily induce letter-sound relationships upon being exposed to whole words. This finding appears to be quite reasonable in terms of concept formation considerations. It is demanding a great deal from a child to expect him to induce the alphabetic principle, and its components, from a presentation restricted to whole words. Silberman's findings, however, are based upon the results of an introductory phonics program which was markedly restricted in duration (less than one school year).

Silberman further asserts from his research work with the beginning reading program that the key to training the generalized skill for reading novel trigrams was auditory blending practice.

138. Sullivan, H. J., Okada, M., & Niedermeyer, F. C. Learning and transfer under two methods of word-attack instruction. *American Educational Research Journal*, 1971, 8(2), 227-239.

The present study was conducted to determine the effectiveness of word-attack instruction based upon a single-letter approach as contrasted with instruction in which common VC and VCC combinations are taught as single grapheme-phoneme units. Effectiveness of the two approaches was evaluated on the basis of subjects' performance in reading (1) new words composed of graphemes taught in the study (i.e., transfer), and (2) graphemes and words practiced in the word-attack instruction during the study

Evidence yielded by the study did not categorically favor the use of one method with all children. Rather, achievement data from the study provide a rather strong indication that the two methods are differentially effective depending on the ability level of the learner.

High-ability subjects who received letter-combination training during the study achieved (99%) on the 80 item posttest, as contrasted with (86%) for high-ability subjects who received single letter training.

Achievement of low-ability pupils under the two treatments contrasts sharply with that of high-ability subjects, as indicated by the significant treatment x ability interaction found in the study. Whereas high-ability pupils performed better under the letter-combination approach, low-ability pupils in the SL group achieved significantly higher scores than low-ability LC pupils both on the entire posttest and on the combined subtests requiring reading of transfer words.

Note: Koehler (1970) reviews the Sullivan work and asserts: The use of sounding out exercises to develop word decoding skills, however, has not led to overwhelming success in word decoding for beginning readers. The SWRL FYCSP uses the training sequence letter-to-sound learning, sounding out program words and blending the sounded-out words. But despite the considerable drill given on the last two steps of the sequence, the end-of-year test results of Mod 1 FYCSP generally show less than 75% accuracy in decoding words. Similar results have also been found in a SWRL study (Sullivan et al.) comparing two methods of word attack instruction. In this case, children over all conditions correctly identified approximately 63% of the transfer words after 6 weeks of instruction, but children who scored very low on the pretest could identify only about 28% of the words.

COGNITIVE PROCESSING

139. Alden, D. G., Wedell, J. R., & Kanarick, A. F. Redundant stimulus coding and keeping-track performance. *Psychonomic Science*, 1971, 22(4), 201-202.

The effect of redundant color coding on keeping-track performance was investigated, using symbols as the primary cue. Subjects were assigned to one of four coding conditions: symbol color (SC), color symbol (CS), symbol only (S), or color only (C). Performance was measured on a task requiring subject to monitor eight information channels, which were being updated randomly. Results indicated that the addition of a redundant color code did not yield a significant improvement in performance, as compared to performance on the component codes (i.e., the S and C groups).

140. Amster, H., & Keppel, G. Letter-sequence habits in children. *Journal of Verbal Learning and Verbal Behavior*, 1968, 7, 326-332.

The characteristics of letter associations in 7-year-old children, 10-year-old children, and college-age adults were compared. The study focuses on developmental changes in letter-to-letter habits, including the specific habits studied on the college-age adults by Underwood and Schulz (1960). With respect to strategies in responding, children showed greater evidence of repetitive strategies, e.g., repetition of a stimulus term, alphabetical responding etc., than adults; but the frequency of meaningful units, e.g., words and initialed abbreviations of institutions, increased with age. In addition, frequencies of specific letter responses for adults tended on the whole to conform more closely to the frequencies in the language than did the children's frequencies. There was also a clear developmental trend toward increased strength of primary with age.

141. Bernbach, H. A. Stimulus learning and recognition in paired-associate learning. *Journal of Experimental Psychology*, 1967, 75(4), 513-519.

The stimulus learning phase of paired-associate learning (PAL) was considered to result from the same process as recognition learning, the storage and retention of a stimulus tag. It was assumed that the availability of the tag is a requirement for the recall of a PAL response, and that if the tag is forgotten the association will be effectively lost. Retention of this stimulus tag was also assumed to be the basis of recognition-memory performance. These assumptions were tested by a continuous PAL experiment in which subjects were required to identify each of a series of 240 consonant trigrams as new or old in addition to anticipating a PAL response, 1 of the digits 1, 2, or 3. Critical items appeared 4 times each, at intervals of 2, 5, or 10 intervening items. Performance on the PAL task was no better than chance on items called "new," and the proportion of correct PAL responses increased with the number of consecutive times that the stimulus was called "old," independent of the number of presentations of the item. This proportion did not, however, increase with the total number of repetitions of the item if the number of consecutive recognitions was held constant.

142. Berry, F. M., & Baumeister, A. A. Partial redundancy and cue selection. *Psychological Reports*, 1970, 26, 171-173.

Normal children learned either "easy" or "hard" paired-associates with or without partially relevant colored backgrounds. The partially redundant conditions (trigram and partially relevant color-cue) produced far more confusion errors at either level of trigram difficulty. Normal children apparently utilized the colors for response evocation even though such a strategy could not lead to total-list learning.

143. Biederman, I., & Checkosky, S. F. Processing redundant information. *Journal of Experimental Psychology*, 1970, 83(3), 486-490.

When stimuli differed on two dimensions (size and brightness), either of which could furnish sufficient information for a correct response, reaction times were faster than when stimuli differed on only one dimension. This result holds true even when individual differences in dimension preferences are taken into account. A model of parallel processing of the different dimensions is proposed and extended to Posner's taxonomy of information-processing tasks. The model emphasizes subject's ability to initiate a successive processing stage as soon as sufficient information for a correct response has been gathered. This ability enables subject to capitalize on the variance of the times of the component processes by which the values of the different dimensions are determined.

144. Biemiller, A. The development of the use of graphic and contextual information as children learn to read. *Reading Research Quarterly*, 1970, 6, 75-96.

Present results from a study of oral reading errors made by 42 children in two first-grade classes from October to May. Errors were analyzed in terms of their contextual constraints ("making sense" in light of preceding context) and graphic constraints (graphic approximation of error response to printed word).

Non-response errors were also studied. Three main phases of development were identified. The first is characterized by a predominant use of contextual information. The second phase is characterized by a predominance of non-response errors and a significant increase of graphically constrained errors (39 vs. 19 percent of response errors). The third phase is characterized by an increase in co-occurrence of graphic and contextual constraints (30 percent of graphically constrained errors were contextually constrained in the first two phases; 70 percent were in the last phase) and in most cases by a reduction of the frequency of non-response errors. It was suggested, and some evidence presented, that the early, context-using phase represents an attempt by the child to avoid using graphic information as much as possible. The non-response phase was interpreted as a shift by the child to attending primarily to graphic information. Possible factors involved in changes in phase and educational implications were discussed.

145. Biemiller, A. Individual differences in the perception of distinctive features of letters and in the use of structural information in reading among elementary school children. Symposium presented at the American Psychological Association, Washington, D.C., 1971.

This report concerns individual differences in three skills involved in early reading: (1) the rate of perceiving distinctive features of letters; (2) the use of structure within words to facilitate reading speed; (3) the use of structure between words--that is, context--to facilitate reading speed.

The basic research problem concerns determining the relative contributions of individual differences in these three variables to general reading ability in the elementary years.

The basic findings are quite simple to summarize. There are large, highly significant, correlations between the three rate measures above grade one. Multiple regression analysis indicates that letter and word rate combined account for well over half the variance in text rates above first grade, while letter rate alone accounts for one third to one half the text rate variance. The mean rates of reading letters, words, and text all decline with age. From second grade to fourth grade, longitudinal correlations, both for the same skill at each age and across skills, are again generally over .70. Looking at other measures, it is found that concurrent and longitudinal correlations between rate measures and reading comprehension test scores are again substantial, while relationships to I.Q. scores generally are not. While at the grade 1 and grade 2 levels, there are some sex differences (which are consistent across letter, word, and text rates) these disappear by fourth grade.

The main conclusion drawn from these findings is that we have in the past probably underestimated the role of individual differences in the basic ability to process visual features, while overestimating the role of whole word perception and the use of context. The data particularly suggests that skills in using contextual information play a smaller role than some researchers such as Goodman (1969) suggest.

146. Bishop, C. H. Transfer effects of word and letter training in reading. *Journal of Verbal Learning and Verbal Behavior*, 1964, 3, 215-221.

The child's process of learning to read was simulated by teaching adults to read several Arabic words. The purposes of the study were to determine the transfer value of training with individual letters as opposed to whole words, and to investigate the role of grapheme-phoneme associations in reading. It was found that letter training had greater transfer value than word training. Knowledge of grapheme-phoneme correspondences was not necessary to read words, but was necessary for transfer to new words. The reason for the overall inferiority of word training was either that it did not direct as many subjects to learn grapheme-phoneme correspondences, or that not all subjects were capable of picking out these relationships when embedded in words.

147. Bloomer, R. H. Reading patterns of the rejected child. *Reading Teacher*, 1969, 22(4), 320-324.

Four hundred fifty-four elementary school pupils were given the *Reading Skills Diagnostic Test*, the *Metropolitan Reading Achievement Test* and a sociometric device to determine accepted, rejected, isolate, and high-impact ambivalence in peer feelings toward the children. Essentially the accepted children, the isolates, and the high-impact ambivalent children performed equally well on the diagnostic reading tests. These groups performed better than the rejected children where the children were required to use analytic and synthetic processes. Studies showed, therefore, that it is the rejected child rather than the isolate who performs poorly and that the area of poor performance is those tasks requiring synthetic and analytic processes.

148. Bourne, L. E., & Haygood, R. C. The role of stimulus redundancy in the identification of concepts. *Journal of Experimental Psychology*, 1959, 58, 232-238.

Two experiments were conducted to test the effects of stimulus redundancy upon the identification of concepts. The task in both experiments was to learn the correct method of classifying visually presented geometric figures. In Experiment I, 180 subjects served in an incomplete factorial design with six levels of redundant relevant information (1, 2, 3, 4, 5, and 6 stimulus dimensions) and three degrees of nonredundant irrelevant information (1, 3, and 5 stimulus dimensions).

In Experiment II, 100 subjects served in a 5 X 2 X 2 factorial with five degrees of redundant irrelevant information (1, 2, 3, 4, and 5 stimulus dimensions), two degrees of nonredundant relevant information (1 and 2 dimensions), and two different problems.

The major findings were: (a) Increases in redundant relevant information improved performance at all levels of irrelevant information. (b) The factilitating effect of redundant relevant information became more apparent as amount of irrelevant information increased. (c) Redundant irrelevant information interfered with performance at both levels of relevant information; however, it had a less inhibiting effect than comparable degrees of nonredundant irrelevant information.

The results were compatible with the effects of redundancy observed in other tasks and were interpreted within the theoretical framework of Restle (1955, 1957).

149. Broadbent, D. E., & Gregory, M. Visual perception of words differing in letter digram frequency. *Journal of Verbal Learning and Verbal Behavior*, 1968, 7, 569-571.

Three lists of five letter words were drawn up, each consisting of 24 words, half of which were AA words in the Thorndike-Lorge count, while half had occurrences between 5 and 25 per million and where therefore relatively uncommon. Each word was typed in lower-case lettering in the center of a Nebro title slide. They were projected onto a screen for group testing through an Aldis projector having a camera shutter to give a fixed exposure of 1/25th sec. Within each frequency class, half the words had a high digram predictability and half a low predictability. The predictability score was calculated as described by Baddeley (1964) from the tables of letter frequencies given by Baddeley, Conrad, and Thompson (1961).

150. Broerse, A. C., & Zwaan, E. J. The information value of initial letters in the identification of words. *Journal of Verbal Learning and Verbal Behavior*, 1966, 5, 441-446.

In most experiments dealing with the relative effectiveness of different word parts in word identification, the greater importance of the word beginning has been ascribed to the sequential order of speech. However, differences in the amount of information must also be taken into account: initial letters contain more information than final letters. In order to determine whether both factors have an effect, an experiment was carried out in which 48 subjects had to guess Dutch 7-letter nouns from a varying number of letters which constituted either the initial or the final word part. For these nouns as a group, beginnings and endings carried equal amounts of information.

The results indicated that both information and serial order in speech were effective. The time required for identification was dependent on the amount of information of the n-gram presented. The subjects also enumerated more 7-letter nouns if the initial letters were available, and as a result identification took less time. In addition, the enumerated nouns were found to be relatively frequent words, and speed of solution was directly related to frequency of occurrence in the language.

The fact that, in the language, word beginnings are more informative than endings might be a consequence of a general psychological rule. In terms of information theory, this rule could be as follows: Taking away uncertainty in the beginning leaves the organism with relatively fewer possibilities to be kept in mind during the whole course of transmission, and for that reason improves the transmission of messages. A "principle of least effort" (Zipf, 1949) applied to the language as a temporal sequence of speaking and reading, would in fact imply that information should be provided by the part of the sequence where its function is optimal.

151. Bruner, J. S., Wallach, M. S., & Galanter, E. H. The identification of recurrent regularity. *American Journal of Psychology*, 1959, 63, 200-209.

We have presented here what is, in effect, a demonstrational experiment. The point of view may be briefly recapitulated: Much of learning and problem-solving can be viewed as a task in identifying recurrent regularities in the environment and this requires either the construction of a model of this regularity or the employment of a model that has previously been constructed by the person. Identification of recurrent regularity is the recognition of pattern complicated by one of two possible factors. Either the recurrent regularity is of a complexity that exceeds the limited cognitive span of the individual, or there are sources of interference either in the stimulus-input, in the required pattern of responding, or in the organism that in effect mask the recurrent regularity to be recognized. Learning, given these interferers, consists, in part, in separating the recurrent regularity to be identified from these interferers. The greater the number of interferers--the more noise there is in the stimulus, the more masking are the responses, the more difficult will identification of regularity be. When these sources are minimized, we have shown, learning is a matter of immediate recognition, provided the pattern can be handled in immediate memory-span. No stimulus-noise and minimal response-interference lead to recognition of a pattern almost immediately.

As in the case of concept-attainment, the first steps in identifying a recurrent regularity require the development of strategies for utilizing potential information from the environment. The greater part of contemporary learning theory has tended to overlook this feature of the learning-process or has treated such information-using strategies as just another kind of response that gets reinforced, if it happens to be followed by tension-reduction.

This study gives evidence, then, that learning and problem-solving may be more profitably viewed as identification of temporally or spatially extended patterns and that the process of learning or problem-solving be viewed as the development of means for isolating such regularities from the flow of irrelevant events that originate either in the enviornment, in the organism, or are produced by the organism's response to the environment.

152. Calfee, R. C., Chapman, R. S., & Venezky, R. L. How a child needs to think to learn to read. Technical Report No. 131, July 1970, Wisconsin Research and Development Center for Cognitive Learning, Madison, Wisconsin.

This report summarizes 1968-69 studies of component pre-reading skills of kindergartners. Working from the assumption that independent component skills might exist, four skill areas were selected for investigation on the basis of literature findings and a decoding model of reading: visual, acoustic-phonetic, letter-sound association, and vocabulary skills. A research strategy is presented for the development and validation of assessment tests in each area and the subsequent development and validation of training procedures. The research reported here is concerned with skill assessment in each of the areas.

The four skill areas were investigated through the use of experimental Basic Skills Test batteries administered individually to kindergartners from a lower-middle class population in Madison (N = 21) and a lower-class population in Beloit (N = 22). Madison subjects participated in three 30- to 50-minute sessions in November, December, and January; Beloit subjects in one 45-minute session in March.

Methods, results, and discussion are presented in detail for each of the four skill areas and invalid test procedures identified (e.g., same-different tests of rhyming). In the remaining tests, errors are examined for sources of difficulty (e.g., left-right letter reversals) and the pattern of interest correlations examined. The findings support an assumption of independent skills related to reading.

153. Calfee, R. C., & Venezky, R. L. Component skills in beginning reading. In Goodman, K. S., & Fleming, J. T. (Eds.), *Psycholinguistics and the teaching of reading*. Newark, Delaware: IRA, 1969.

The majority of experiments on reading have explored the relative efficiency of various methods or materials. Of the many techniques that have been tried, the folklore is that, 1) most techniques seem to work with most children, but all fail with some children; 2) there appears to be no best method; and 3) the efforts of the teacher appear to override in importance the effects of variation in methods or materials.

Like others, the writers would like to find more effective ways to teach reading. It seems futile to introduce more new methods until necessary insights into the nature of the reading process are established by appropriate research. Dissection of the process into its components is an impossible venture when each measure correlates with every other measure to the same extent--hence, the concern with testing procedures. The writers are optimistic about the possibility of finding reliable instruments sensitive to well-defined skills and would be quite pleased to find that tests of articulation and discrimination ability were only slightly correlated with one another and that neither was significantly related to performance on current readiness or achievement tests. After all, it is hard to believe that the sum total of a child's intellectual ability can be measured by his knowledge of the letters of the alphabet prior to first grade. Reading is a vital skill, without which a child cannot succeed in virtually any other area. Today, it is possible to predict quite reliably those children who are not going to make it. This damning prediction must be changed into a prescription for treatment.

154. Cohen, B. H. An investigation of recoding in free recall. *Journal of Experimental Psychology*, 1963, 65(4), 368-376.

Four studies were conducted to evaluate G. A. Miller's chunk hypothesis. 70-word lists comprising 10 exhaustive and 10 nonexhaustive categories of words were presented for free recall. The results indicated that: (a) whether category recall was inferred from word recall or measured directly, betweeen 10 to 14 categories were represented in recall; (b) significantly more words of exhaustive categories were recalled; (c) the 2 category types were used equally in recall; (d) there was a strong tendency to cluster related words in recall; and (e) an index of inter-item associative strength, derived from word association norms, discriminated differences in recall between the 2 category types and was significantly related to within-category recall. The results were interpreted as providing support for Miller's position regarding recoding.

155. D'Amato, M. F., & Ryan, R. Intradimensional and extradimensional shifts in compound concept learning. *Psychonomic Science*, 1967, 7, 207-208.

Following pretraining in a two category concept task with one of two dimensions relevant, subjects were shifted to a second concept task requiring four response categories with two of three dimensions relevant. Training on the second (compound) concept involved either an intradimensional, an extradimensionl, or a control shift relative to pretraining. Compound concept learning requiring an IS was shown to be superior to learning requiring an ES, and to yield positive transfer. Compound concept learning requiring an ES did not produce negative transfer.

156. Deese, J. Influence of inter-item associative strength upon immediate free recall. *Psychological Reports*, 1959, 5, 305-312.

Lists consisting of 15 words each were presented to subjects for immediate free recall. For each of the 18 lists a measure of inter-item associative strength was obtained, this consisted of the average relative frequency with which all items in a list tend to elicit all other items on the list as free associates. Inter-item associative strength was positively correlated (.88) with the number of words recalled per list, negatively correlated (-.48) with the number of extra-list intrusions in recall, and positively correlated (.55) with the commonality of the extra-list intrusions that did occur. In general, these results are consistent with an interpretation of free recall in terms of free association. Free association, as it occurs in recall, is probably a direct, unmediated activity with little or no active editing of the material being recalled. The data on intrusions from the present experiment are consistent with the assumption of lack of editing. The fact that subjects in the present experiment gave no evidence of using an extra-list associative mnemonic device made available to them suggests that the free association from item to item in recall is not the result of subjects' instructing themselves to free associate in order to increase recall.

157. Desberg, P., & Berdiansky, B. Word attack skills: Review of literature. Technical Report No. 3, June 1, 1968, Southwest Regional Laboratory, Inglewood, California.

This report is intended to serve as a summary of the recent literature on word attack. The literature is characterized by an abundance of non-experimental, prescriptive articles. Empirical investigations tend to cluster in a few areas, most notably those of word and letter discrimination.

The first half of the report deals with the major reading systems currently in use. To a large extent, these systems lack an empirical base for both their subject matter and instructional procedures. The second half of the report reviews reports of current word attack research. This research, although usually generated from a theoretical position, is largely concerned with answering isolated questions. However, the results of these studies appear to have widespread generalizability. A brief review of the major findings of these studies is presented here.

Marchbanks and Levin (1965), Bishop (1964), and Samuels and Jeffrey (1967) found: a) letter cues, and not whole-word shape cues, are the basis by which non-readers and beginning readers recognize words; b) training in making grapheme-phoneme associations has more transfer value than does whole-word training; and c) the use of single letters as cues in word identification increases with dissimilarity of stimuli and results in more reading errors than do multiple-letter cues (the latter being necessary when word stimuli are more similar).

From such research, Gibson et al. (1962, 1963, 1964), the Stanford project (1964), and Levin and Watson (1964) hypothesized that the proper unit for word recognition is the grapheme-sequence, with its corresponding, environment-influenced phonemes. Levin and Watson confirmed their hypothesis that the learning of variable, rather than constant, grapheme-phoneme correspondences would have greater transfer to the learning of new correspondences. In another experiment they found that although an original constant-correspondence list results in subsequent variable lists being easier to acquire. In other words, V_1V_2 transfer is greater than V_1C_2 or C_1C_2 or C_1C_2 transfer.

The Stanford project (1964) used an interdisciplinary approach in their computer-assisted reading instruction program. The primary reading instructional unit used in the Stanford project is the vocalic center group. Rules for the specification of vocalic center groups approximate, but are not identical to, dictionary syllabification rules.

In a series of experiments, Gibson et al. (1962, 1963, 1964) confirmed their hypothesis that pronunciability (grapheme-phoneme regularity) is functionally related to perception. Upon testing deaf subjects, however, Gibson et al. (1966) found it necessary to modify this hypothesis to include graphotactics and the morphophonemic level of rules postulated by Venezky and Weir (1966).

Venezky and Weir have made the most complete investigation of English orthography and corresponding pronunciation to date. Their work is based on the hypothesis that "...English spelling is not simply a defective phonemic system for transcribing speech, but instead, a more complex and more regular set of patterns in which both phonemic and morphemic elements share leading roles" (Venezky & Weir, 1966). Hypothesizing that English is a systematic, though complex language, and recognizing the arbitrary nature of rules, Venezky and Weir determined more appropriate spelling-to-sound rules for reading instruction and vocabulary selection. It is their use of the morphophonemic level of rules, mediating between a grapheme, or grapheme-sequence, and a phoneme, that accounts for greater regularity in the language than that allowed for by the traditional investigators.

Future research in reading instruction, hopefully, will:

1. systematically study the English language to determine an explicit subject matter; that is, extend Venezky and Weir's work;

2. use an interdisciplinary approach, as the Stanford project is doing;

3. make further investigations of the stimulus units to which the beginning reader attends, as Marchbanks and Levin, etc. attempted; and

4. empirically validate the language-based subject matter, identification techniques, and systematic instructional methodology on relevant populations (non-readers and beginning readers).

158. Dick, S., & Landau, J. S. Attribute learning in preschool children: Mediation and selection mechanisms. *Psychonomic Science*, 1970, 21(2), 105-107.

Preschool children learned to respond to a black vertical line and were tested for orientation, form, and color generalization under two test procedures. The results indicated that (1) a procedure which approximated successive generalization testing (N) provided little evidence that any of the tested-for attributes were learned, whereas a procedure which contained dimensional "orienting" properties (0) indicated that each tested-for S+ attribute was learned; (2) group anslyses of the 0 procedure suggested a hierarchical arrangement of learned attributes; however, additional analyses failed to reveal hierarchies for individual subjects. The results suggested that during training the S+ complex activates for different individuals either one, two, or three attribute mediators and that during Phase II, properties of the test operate to select activated mediators to control test behavior.

159. Ebenholtz, S. M. Serial learning: Position learning and sequential associations. *Journal of Experimental Psychology*, 1963, 66(4), 353-362.

A serial list may be mastered by learning the location of the items relative to the beginning and end of the list, by forming sequential associations between successive terms, or on the basis of both processes. Two experiments yielded evidence for the role of position learning as opposed to sequential associations. One experiment compared the usual method of serial learning with one in which subject began each trial at a different point in the sequence. The latter procedure produced significantly greater difficulty even though sequence and number of associations were identical in both conditions. The second experiment demonstrated faster learning for items on a second list which occupied identical positions on both original and transfer lists than for items appearing at noncorresponding positions. In addition, a test of associative interference under conditions of serial learning yielded negative results thereby failing to support the sequential association hypothesis.

160. Edelman, G. The use of cues in word recognition. In Levin, H. (Ed.), *A basic research program on reading*. New York: Cornell Press, 1963.

The basic problem with which this study is concerned is the visual recognition of words by non-readers and beginning readers. When a child is confronted with a word he has never seen and is asked to remember it, he must utilize some identifying mark, i.e., a cue. The purpose of this study is to discover which cue or cues are the most important.

A delayed-recognition task was constructed with trigrams and second letter paralogs. The subjects were 50 kindergarteners and 50 first graders.

The research findings were:

1. Letter cues, and not shape cues are the bases by which kindergarteners and first graders recognize words.

2. The first letter of a word is the most important cue in word recognition.

3. The last letter of a word is used as the second most important cue in word recognition except for first graders who know the alphabet very well; they tend to use the letter cues in their order from left to right, the first being the most important cue, the second letter next in importance, etc.

4. Some kindergarten boys utilize the last letter as the most important cue in a word, and the first letter as the second most important cue.

5. In short three-letter words, the last letter is a more important cue than it is in longer, five-letter words.

6. The implications of these conclusions for teaching reading are that the letters ought to be taught more thoroughly so that beginning readers might utilize all the letter cues in a word to their advantage, rather than just the first and last letters, which they apparently do without instruction.

161. Eimas, P. D. Multiple-cue discrimination learning in children. *Psychological Record*, 1969, 19, 417-424.

Kindergarten, second- and fourth-grade children were trained on a simultaneous discrimination with either 2, 3, or 4 relevant and redundant visual cues. Test trials were given which measured the acquisition of choice responses to each of the relevant cues separately. The children, with the exception of one training condition, learned something about 2, often 3, and in some individual cases 4 cues, the number increasing with CA and MA. With an increase in the number of relevant cues, the amount learned about any one cue deceased and the number of cues about which something was learned was reduced for kindergarten and second-grade children. The results were discussed in terms of a limited capacity to utilize redundant information, which increases with developmental level.

162. Elkind, D. Discrimination, seriation, and numeration of size and dimensional differences in young children: Piaget replication study VI. *Journal of Genetic Psychology*, 1964, 104, 275-296.

Ninety children, 30 at each age level from 4 to 6-7, were tested for their ability to discriminate, seriate, and numerate size differences in one-, two-, and three-dimensional materials. Results show a regular increase with age in the child's ability and show that the dimensionality of materials affects the ease of success, but not the sequence of success, on discrimination, seriation, and numeration tasks. The results are in agreement with those secured by Piaget. In the discussion, an attempt was made to present Piaget's theory on the development of conceptual ability in general and on the development of the conceptions of a series and of a seriated class (number) in particular. The author concludes that Piaget's theory accounts not only for empirical findings, but also points up the psychological complexities and difficulties that underlie such apparently simple activities as constructing a stairway or determining how many stairs a doll has climbed to reach a particular stair.

163. Ellis, H. C., & Muller, D. G. Transfer in perceptual learning following stimulus predifferentiation. *Journal of Experimental Psychology*, 1964, 68(4), 388-395.

Two experiments on stimulus predifferentiation were conducted to test the acquired distinctiveness of cues and differentiation hypotheses of perceptual learning. In the first, 240 subjects were given a recognition test following stimulus predifferentiation training. Observation training yielded superior recognition of 6-point shapes and distinctiveness pretraining yielded superior recognition of 24-point shapes. The former result was consistent with differentiation theory and the latter with acquired distinctiveness. In the second, 30 subjects received stimulus predifferentiation training followed by a discriminative transfer task. Distinctiveness pretraining yielded greater positive transfer than observation, a result consistent with acquired distinctiveness of cues.

164. Epstein, W. The influence of syntactical structure on learning. *American Journal of Psychology*, 1961, 74, 80-85.

This experiment was designed to study the role of syntactical structure in verbal learning. Syntax can be defined as the generalized pattern or schema which is imposed upon the reservoir of available words and determines the sequence of these words. The fact that verbal messages in ordinary usage are encoded according to a set of grammatical rules may make the learning of natural linguistic units very different from the learning of a series composed of independent items, e.g., a list of nonsense syllables.

An experiment was performed which showed that syntactical structure facilitates verbal learning apart from the contributions of meaningfulness, familarity, and sequential probability. Possible explanations of this effect were discussed.

165. Follettie, J. F. Evaluation of word attack skills. Technical Memorandum No. TM-1-71-2, 1971, Southwest Regional Laboratory, Inglewood, California. (a)

A framework for more apt and sensitive evaluation of generalized word attack skill--the heart of oral reading skill--is presented. The paper envisions the design and development of oral reading instruction as bounded by a fully-specified evaluation scheme.

166. Follettie, J. F. Word attack model. Technical Note No. TN-1-71-11, 1971, Southwest Regional Laboratory, Inglewood, California. (b)

A quasi-formal model explicates a number of factors underlying investigation of effectiveness of alternative segmentation-blending rules in preliminary phonemic-level word attack instruction. Being taxonomic, the model does not predict; rather it reveals conditions to which segmentation-blending hypotheses of potential interest reference.

167. Forgays, D. G. The development of differential word recognition. *Journal of Experimental Psychology*, 1953, 45, 165-168.

The relationship between educational grade level and recognition of words tachistoscopically exposed to the left and right peripheral fields of vision was investigated. The total recognition of words was found to increase significantly with increase in educational experience. Further, recognition of words exposed to the right field was found to be significantly greater than for words presented to the left of fixation. The superiority of recognition of words presented to the right of fixation over the left is significantly related to educational grade level.

These results support the position that separate parts of a receptor surface may come, during a process of training, to evoke different percentages of correct response. In support of earlier experimentation, these results are inconsistent with a theory of a general equipotentiality in vision.

168. Garner, W. R. *Uncertainty and structure as psychological concepts.* New York: John Wiley & Sons, 1962. Summary of Chapter 8, The use of language redundancy.

Human subjects are aware of the particular nature of the redundancy in their language, and this awareness can be demonstrated in a number of ways. Subjects are able, for example, to produce distributions of letters and use of words in proportion to their actual occurrence in English.

Knowledge of sequential constraints can also be demonstrated by direct performance of subjects. They can replace missing letters or words in sequences of letters or words with considerable accuracy, and their accuracy in such a task corresponds well with the amount of predictability or constraint available in the presented stimulus materials. Similarly, recognition accuracy for letters in words depends on the position of the letters in words. The high-information end letters are recognized more quickly, but reversal of such letters affects recognition accuracy more than does reversal of low-information middle letters.

Several experiments on learning have shown that learning is better when the patterns of letters or words correspond to those in actual English. Furthermore, the introduction of artificial sequential constraints improves the learning of single passages.

We expect that redundancy should make free-recall learning more difficult, and one experiment indirectly confirms this expectation. Form of redundancy research confirms our expectations that high contingencies between letter pairs should aid free-recall learning.

It is not entirely clear whether discrimination-learning tasks, such as serial learning, are aided by increased redundancy, but there is some suggestion that such learning is improved.

169. Garner, W. R. Speed of discrimination with redundant stimulus attributes. *Perception and Psychophysics*, 1969, 6(4), 221-224.

Speed of sorting decks of 32 cards with two alternative stimuli was measured. The stimuli were pairs of dots with attributes of distance between dots, angle of orientation of the pair, and position of the pair to the right or left of center. The attributes varied in relative discriminability and were used in all possible pair- and triple-correlated (redundant) combinations. Results showed an increase in speed of sorting with either an increase in discriminability or an increase in number of redundant attributes. It is argued that the increased speed with addition of redundant attributes is due both to a selective serial processing of attributes (requiring attribute separability) and to an increased discriminability with combined attributes (requiring attribute integrality).

170. Gibson, E. J., Farber, J., & Shepela, S. Test of a learning set
procedure for the abstraction of spelling patterns.
In Levin, H. (Ed.), *A basic research program on reading*.
New York: Cornell Press, 1963.

Research findings seem to indicate that spelling patterns have a structure in their own right, which apparently can be learned quite apart from the fact that every word they produce maps predictable into the spoken language. Sound thus seems to be necessary for the processing of higher-order units in reading. The normal skills reader, however, probably uses not only the structure inherent in spelling patterns but also his knowledge of the rules of the spoken language, and the higher order relations between these systems. He may well process written material on several levels. It seems to us that some knowledge of how the grapnic information itself is utilized is preliminary to our understanding of these more complex processes.

Subjects were kindergarten and first grade students. For stimuli, we devised a series of discrimination problems, each one consisting of four pairs of four-letter words, half of which (the positive set) contained a common two-letter "pattern." The possible patterns corresponded to initial and final consonant clusters, vowel clusters, or disjunctive "final e" units. A negative instance differed from the corresponding positive in one of the letters in the pattern only. The negative set itself contained no pattern, since research in concept identification (so far) suggests that a constraint within the negative instances makes the concept harder to attain. Four of these pairs, repeated four times according to a Gellerman series, comprised a set.

The task was definitely easier for the first graders, 3/5 of 60% of whom showed evidence of forming a learning set, as contrasted with 1/12 of 8.3% of the kindergarten subjects. Criterion for learning set was a progressive increase in the percentage of problems solved per day with a final level of at least 80%.

The progression in levels of abstraction in these styles of learning word discriminations or (when it happens) spelling patterns, suggests that we may, as one of our next steps, be able to work out a program for introducing problems so as to "shape" a child toward progressively higher order abstractions.

171. Gibson, E. J., & Guinet, L. Perception of inflections in brief visual presentations of words. *Journal of Verbal Learning and Verbal Behavior*, 1971, 10, 182-189.

An experiment was performed to investigate whether one aspect of syntax, verb inflection, creates units for perception in brief visual presentations of words and pseudowords. Inflections did tend to function as units, but not to increase the length of a word that could be read tachistoscopically. Priority of processing inflected endings occurred when the base was not a real word. It was concluded that words are read as complexes of features, of which syntax is one type, and that these features are processed independently.

172. Gibson, E. J., Osser, H., & Pick, A. D. A study of the development of grapheme-phoneme correspondences. In Levin, H. (Ed.), *A basic research program on reading*. New York: Cornell Press, 1963.

The research hypothesis asserts that higher-order rules exist which predict sound from spelling and that these are assimilated by the skilled reader with the effects of organizing larger units for perception and predicting the way to read hitherto unseen words. The question examined in this paper is how the correspondence rules are learned.

An experiment was designed to compare children at the end of grade 1 and at the end of grade 3 in ability to recognize familiar three-letter words, pronounceable trigrams and unpronounceable trigrams. Twenty-four subjects just completing first grade and 24 subjects just completing third grade were chosen at random from and average+ income school population.

The results of this study can be summarized as follows:

1. Familiar three-letter words which had been practiced as units were read more accurately by all the first graders tested and by the third grade boys than were non-word trigrams.

2. Pronounceable trigrams were read more accurately than unpronounceable ones by the same children, with both letter and trigram frequency controlled.

3. Third-grade girls read all three-letter combinations with high and equal accuracy, resembling adult readers.

4. Span (length of word which can be read under these conditions) increased from first to third grade.

5. As span increased, a difference in reading accuracy also developed between longer pronounceable and unpronounceable pseudo-words.

6. Tentatively it is concluded that a child in the early stages of reading skill typically reads in short units but has already generalized certain consistent predictions of grapheme-phoneme correspondence, so that units which fit these simple "rules" are more easily read. As skill develops, span increases and a similar difference can be observed for longer spans. The longer items involve more complex contingency rules and longer vowel and consonant spellings, so that the generalizations must increase in complexity as the span increases. Thus, the second hypothesis suggested in the introduction is supported. Even though a child is presented with "whole words" and encouraged to associate the printed word as a whole with the spoken word, he still begins to perceive some regularities of correspondence between the printed and written terms and transfers these to the reading of unfamiliar items. This generalizing process undoubtedly promotes reading efficiency and could be facilitated by presenting material in such a way as to enhance the regularities and speed up their incorporation.

173. Gibson, E. J., Pick, A., Osser, H., & Hammod, M. The role of grapheme-phoneme correspondence in the perception of words. *American Journal of Psychology*, 1962, 75, 554-570.

The hypothesis has been proposed that the proper unit of the reading process is neither the single letter nor the whole word but a higher-order invariant derived from grapheme-phoneme correspondences. Rules can be drawn up for predicting spelling from sound if temporal patterning of "clusters" is taken into account. It was proposed that the skilled reader has learned to perceive as units the letter-patterns conforming to these rules and that such patterns have, therefore, an advantage in reading.

Several experiments were performed to test this hypothesis. Pseudo-words conforming to rules of spelling-to-sound correlation were compared with ones of low correlation under conditions of tachistoscopic viewing.

In the first experiment, it was found that the subjects reproduce pseudo-words of high correlation more accurately than ones matched for summed letter-frequency, but of low correlation.

In a second experiment, comparable results were obtained when the subjects were not asked to reproduce a word, but performed perceptual matching of the word exposed tachistoscopically with a member of a multiple choice list. It was concluded that the perceptual process has been facilitated in skilled readers for units discovered during long exposures to the grapheme-phoneme correspondences of the English language.

174. Gibson, E. J., Shurcliff, A., & Yonas, A. Utilization of spelling patterns by deaf and hearing subjects. In Levin, H., & Williams, J. P. (Eds.), *Basic studies on reading*. New York: Basic Books, 1970. Pp. 57-73.

An experiment was reported in which deaf and hearing subjects were compared for the ability to read, under tachistoscopic presentation, letter strings (pseudowords) that did, or did not, follow the rules of orthography that rendered them pronounceable or relatively unpronounceable. Deaf as well as hearing readers were more successful in reading the pronounceable ones. This finding must mean that orthographic rules were used by these subjects even though the invariant sound mapping was not available to them. Research is needed to show the best way to teach or promote induction of spelling patterns in order to promote skill in processing written language in units that reduce the information load.

175. Gibson, J. J., & Gibson, E. J. Perceptual learning: Differential or enrichment? *Psychological Review*, 1955, 62, 32-41.

There is no evidence in all of this literature on perceptual learning, nor is there evidence in the experiment reported in the last section, to *require* the theory that an accurate percept is one which is enriched by past experience, whereas a less accurate percept is one *not* enriched by past experience. Repetition or practice is necessary for the development of the improved percept, but there is no proof that it incorporates memories. The notion that learned perception is less and less determined by external stimulation as learning progresses finds no support in these experiments. The observer sees and hears more, but this may be not because he imagines more, or infers more, or assumes more, but because he discriminates more. He is more sensitive to the variables of the stimulus array. Perhaps the ability to summon up memories is merely incidental to perceptual learning and the ability to differentiate stimuli is basic. Perhaps the dependence of perception on learning and the dependence of perception on stimulation are not contradictory principles after all.

This theoretical approach to perceptual learning, it must be admitted, has points of weakness as well as points of strength. It accounts for veridical perception, but it does not account for misperception. It says nothing about imagination or fantasy, or wishful thinking. It is not an obviously useful approach for the study of abnormal behavior or personality, if one is convinced that a man's perceptions are the clues to his motives. But if one is concerned instead with the practical question of whether training can affect favorably a man's perception of the world around him, a very productive field for theory and experiment is opened up.

176. Goldstein, D. Review of paired-associate learning in K-3 age groups. Technical Note No. TN-2-70-42, 1970, Southwest Regional Laboratory, Inglewood, California.

Relevant studies of the paired-associate (PA) learning of children in grades K-3 are reviewed and evaluated. Although most of the normative data about PA learning in adults has not been replicated with children, two other particularly fruitful lines of research have emerged. First, the investigation of imaginal and syntactical mediation processes has shed new light on learning in childhood and is a potential link with developmental psycholinguistics. Second, refinement of the Underwood and Schultz "two-stage" model of PA learning may be attempted with children.

177. Hall, V., & Caldwell, E. Analysis of young subjects performance on a matching task. Research Report, Document Number 70706-AI-R-29, 1970, Syracuse Center for Research and Development in Early Childhood Education.

The purpose of the present study was to show that when young subjects are shown through a brief training period that orientation is important in deciding whether two shapes are called same or different, these subjects will perform significantly better than subjects not given the training period.

Subjects were 20 nursery school children randomly selected from approximately 100 children enrolled at a nursery school supported by the Syracuse branch of the National Laboratory for Early Childhood Development.

The results are displayed in Table 1. It is clear that the subjects in the condition in which the experimenters definition of same and different was made explicit performed significantly better than the replication group ($t = 1.95$, 1/9 df, $p < .05$). The experimenter would strongly suggest that once again failure of the experimenter to properly analyze the experimental demands in a particular task has led to an incorrect inference concerning young subjects ability to perform relatively simple tasks.

178. Harris, L. Interest and the initial acquisition of words. *Reading Teacher*, 1969, 22(4), 312-314.

While evidence or opinion concerning the importance of reader-interest in learning to read is largely unequivocal, the interest loading of individual words as a factor in acquisition has not been put to empirical test. If individual words selected on the basis of their appeal were found to be acquired and retained more readily than other words, a strong case for their inclusion in reading materials could be made. This investigation was designed to provide some evidence on this matter. In this study, words of high interest to boys and words of high interest to girls were identified and presented to low socio-economic youngsters to explore the acquisition of such words. Interest-loaded words or words of high appeal were selected in a six-step procedure prior to the main investigation. The words selected were airplane, football, rocket and truck, as boy-words; ballerina, playhouse, teaset, and fairy as girl-words.

Conclusions and Implications

1. Interest-loading of words is unrelated to acquisition among low socio-economic children. The findings indicate that the subjects acquired words of high interest and words which are not of high interest equally well.

2. Kindergarten children from low socio-economic schools do not retain for even a short time words which they have acquired.

3. Interest-loading was not demonstrated in this investigation to be important in the acquisition and retention of words by low socio-economic kindergarten children. It is possible that interest-loading is not an important factor in word acquisition and retention among such children. On the other hand, the low performance of the sample studied may have masked the influence of sex-loading of words.

From this study it seems evident that without special preparation low socio-economic children cannot be expected to perform adequately in acquiring or retaining words on learning tasks such as those presented in this study. While specific factors causing low performance were not identified in this investigation, it is possible that the specific tasks were not appropriate.

179. Jeffrey, W. E. Effect of meaning and direction of training on mediated association. *Psychological Reports*, 1957, 3, 555-560.

An experiment was designed to compare groups learning under two mediation paradigms with control groups for acquired distinctiveness and warm-up. Retroactive inhibition, an integral part of such designs, was minimized by using a motor response as the criterion task. The association value level of the nonsense syllables used as stimuli and responses was varied. There was no question of the superiority of the mediation procedure over the acquired distinctiveness and warm-up procedures. The mean performance of the group following a semantic generalization paradigm, as it was called here, fell between the mediation and acquired distinctiveness groups. The effect of the different association levels on performance was highly significant but there was no statistically demonstrable interaction with the training effect.

180. Jeffrey, W. E., & Samuels, S. J. Effect of method of reading training on initial learning and transfer. *Journal of Verbal Learning and Verbal Behavior*, 1967, 6, 354-358.

Letter (phonic) and word (look-say) methods of reading training were compared with regard to transfer of training to new words. The graphemes were completely novel although the phonemes and words were familiar. The letter-training group was superior to the word-training group on the initial transfer trial as well as on a learning performance measure. Intelligence proved to be a significant variable in transfer but not in initial training.

181. Karsh, R. Keeping track of sequential events: Multiple tallies and information rate. *Journal of Experimental Psychology*, 1970, 84(2), 339-342.

The ability to keep track of sequential events was examined as a function of the rate of stimulus presentation and the number of categories of information displayed simultaneously. It was found that performance was a function of the "information rate" defined as the first aforementioned variable divided by the second variable. Implications for a theory of keeping-track performance are discussed.

182. Keely, K. Age and task effects in short-term memory of children. *Perception and Psychophysics*, 1971, 9(6), 480-482.

Children of 4, 8, and 14 years performed a visual memory task with easy- or hard-to-label displays and with or without repetition of stimuli over trials. Eight pictures were displayed in serial order, and the task was to find the card in the array that matched an identical probe card. Performance improved with age, and strong serial position effects were obtained for all ages and tasks. In contrast to previous studies, primacy effects were obtained for the youngest children tested. Task difficulty increased with difficulty of labeling and with repetition, but order of task difficulty remained the same for all ages. The d' measure, borrowed from signal detection theory, revealed differences in criterion levels over serial position, which in earlier studies had been confounded with strength of memory.

183. Klahr, D., & Wallace, J. G. The development of serial completion strategies: An information processing analysis. *British Journal of Psychology*, 1970, 61(2), 243-257.

An information processing model of a complex task involving several important Piagetian concepts is introduced and then extended to a more difficult class of problems often used to test adult cognitive abilities. In comparing this extended model both to human performance and to the process model by Simon & Kotovsky, the criterion of developmental tractability is introduced. A detailed study of a child's performance during a crucial transition from one stage of problem complexity to another indicates that a mixture of both models seems to provide the best explanation of problem-solving behaviour.

184. Krueger, L. E. Effect of frequency of display on speed of visual search. *Journal of Experimental Psychology*, 1970, 84(3), 495-498. (a)

Deeply-ingrained familiarity with a sequence of letters aids visual search, since subjects search more rapidly for a target letter through words than nonwords (Krueger). In the present study, familiarity was induced within an experimental session by repeating certain sequences or displays. The adult subjects searched more rapidly through repeated than nonrepeated displays.

185. Krueger, L. E. Search time in a redundant visual display. *Journal of Experimental Psychology*, 1970, 83(3), 391-399. (b)

The subjects searched more rapidly for a target letter through real words and third-order pseudowords than nonwords (scrambled collections of letters), and more rapidly through common words than rare words. The subjects also searched more rapidly through coherent sentences than the same words in scrambled lists. Two models (based on ones by Sternberg) are proposed to explain how redundancy speeds search for a letter: Model A holds that redundancy aids encoding, so that a stimulus representation is formed more rapidly of a word than a nonword; Model B holds that redundancy aids the subsequent memory comparison process, so that a letter in a word is matched more rapidly with the memory image of the target letter. When two subjects looked for several letters at a time, rather than one, and thus had to make more memory comparisons, search time increased, but not the time savings for words. These results support Model A.

186. Lawrence, D. H. The transfer of a discrimination along a continuum. *Journal of Comparative Physiological Psychology*, 1952, 45, 511-516.

This study was suggested by a number of incidental observations in the experimental literature. These observations seemingly indicate that a difficult discrimination is more easily established if the subjects are first trained on an easy discrimination of the same type than if all the training is given directly on the difficult discrimination (3, 4, 7). The greatest efficiency seems to result, moreover, if the transition from the easy to the difficult discrimination is gradual rather than abrupt. If it is assumed that these results still hold when controlled for the total number of practice trials or reinforcements involved, they conflict with the usual expectations as regards the transfer of training. Normally it is assumed that for a fixed amount of practice on a training discrimination, the transfer effect to a test discrimination will be greatest when the training and test discriminations are identical. The above observations are in conflict with this assumption in that transfer is greatest between nonidentical discriminations. Consequently, if they are correct, they place limitations on the various theories of discrimination learning, especially those formulated in terms of generalization gradients. The present experiment is designed to check these observations under the condition of controlled number of training trials.

187. Levin, H., Baum, E., & Bostwick, S. The learning of variable grapheme-to-phoneme correspondences: Comparison of English and Spanish speakers. In Levin, H. (Ed.), *A basic research program on reading.* New York: Cornell Press, 1963.

This study follows on several others which found that children trained to learn two verbal associates to a single graphic stimulus generalized this skill to the learning of subsequent variable associations. This learning problem is designed as an analog to learning grapheme-to-phoneme correspondences as a part of the process of learning to read. However, the study repeated with Italian children indicated that the variable condition was difficult to learn and only the constant condition yielded positive transfer effects. In this study, we tested the hypothesis that variable associations were difficult for readers of a language which had low instance of variable associations. Forty subjects whose native language was Spanish and forty speakers of English learned one of four combinations of lists: constant-variable, C-C, V-C, V-C. Variable lists were somewhat more difficult for the Spanish than for the English speaking as subjects. Both initial training on constant and variable lists yielded a savings in learning the second lists of the same type. We have argued that since learning to read English requires variable associations of the type that we have studied, it would be well to train initially on variable instances.

188. Levin, H., & Watson, J. The learning of variable grapheme-to-phoneme correspondences. In Levin, H. (Ed.), *A basic research program on reading.* New York: Cornell Press, 1963. (a)

Based on speculations about how children might be taught to read, the hypothesis was tested that children more easily acquire and transfer grapheme-to-phoneme correspondences which are variable than those that are constant. That is, when a given graphic symbol stands for two or more sounds, it should be learned and transferred more readily when the variations are learned together than when they are learned separately.

Two groups of third grade children learned lists of words in this order: constant followed by a variable list compared to variable followed by a variable list. Both groups then learned a common transfer list of words. The V-V groug learned its second list with less trials and errors than the C-V group. They did not differ on the transfer list.

A subsequent analysis of the confusion errors on the various lists indicated that words which share an initial grapheme and phoneme are most confused with each other; sharing terminal elements are next as a source of confusion; and words with no common elements are least confused.

189. Levin, H., & Watson, J. The learning of variable grapheme-to-phoneme correspondences: Variations in the initial consonant position. In Levin, H. (Ed.), *A basic research program on reading*. New York: Cornell Press, 1963. (b)

This study tested the propositions that a list containing variable grapheme-to-phoneme correspondences is easier to learn than a list in which the associations are constant and that training on the variable list would facilitate subsequent variable list learning. The evidence for the first hypothesis is clearly contrary to the prediction: given no prior experiences with such lists of words, constant lists are acquired with fewer errors.

The second prediction was confirmed: most efficient learning occurred when two variable lists followed each other, compared to the conditions of variable or constant lists following an initial constant list, or a constant list after prior learning of a variable one.

An analysis of intralist confusion errors indicates that errors are due to words sharing common graphic stimuli rather than to common sounds.

190. Levin, H., Watson, J. S., & Feldman, M. Writing as pretraining for association learning. In Levin, H. (Ed.), *A basic research program on reading*. New York: Cornell Press, 1963.

This study was designed to test the effects of writing as pretraining for association learning. Forty children, six years old, learned to associate eight English words with an artifical orthographic representation of these words. The subjects were divided into four pretraining groups: one group traced the initial graphme of the "words"; another, the terminal graphemes; the third group traced the medial graphemes; and a control group had a warm-up period.

The group trained on the initial graphemes had the highest number of correct associates and performed best on a recognition test. Next were the subjects trained on terminal graphemes. The group trained on the medial elements did more poorly. However, the control group performed at a level between the initial and terminal grapheme-trained groups. The results are discussed in terms of the relevance of pretraining to the specific cues used in association learning.

191. Levin, J. R. Verbal organizations and the facilitation of serial learning. *Journal of Educational Psychology*, 1970, 61(2), 110-117.

One hundred-twelve fourth and fifth graders from an upper-middle-class population were given a twelve-item serial list to learn. The items consisted of high-frequency nouns, and subjects were assigned to different experimental conditions in which to learn them. In the sentence conditions, the nouns were presented in the context of one or more sentences, while in the control condition, the nouns were presented without companion sentences. Relative to the control group, it was found that the provision of sentences per se was not a sufficient effector of facilitated performance on the task. Only in the conditions where the sentences were used to relate three or more successive items to one another was facilitation observed. Furthermore, these relationships obtained under two kinds of testing procedures (a) serial anticipation, where immediate (4-second) feedback was supplied regarding the correctness of the subject's performance; and (b) serial recall, where feedback was delayed (52 seconds). In terms of overall serial learning proficiency, no differences were found between the two methods of providing feedback when appropriate measures of performance were adopted.

192. Lipsitt, L. P. Simultaneous and successive discrimination learning in children. *Child Development*, 1961, 32, 337-347.

The results of three discrimination learning studies of normal fourth grade children are reported. Comparisons of the methods of simultaneous and successive stimulus presentation are made under different levels of stimulus similarity and two types of response, either directly to the stimulus source or to a locus (buttons) removed from the stimulus source. The results of the three studies agree very well with the following propositions:

1. When response is directly to the stimulus source, simultaneous stimulus presentation tends to result in better learning than successive.

2. When the response is to a locus removed from the stimulus source, successive stimulus presentation may result in performance equal to or better than simultaneous.

3. The nature of the response involved in discrimination learning interacts with stimulus similarity, such that in procedures involving response to a locus removed from the stimulus source simultaneous may produce better learning than successive if the stimuli are very highly similar.

It is concluded that the relative ease of simultaneous and successive discrimination learning in children is a joint function of stimulus similarity and the type of response required. It is suggested further that other manipulable conditions undoubtedly interact with the two dealt with here and that possibly stimulus generalization is the mechanism underlying the effects of each.

193. Loess, H. B., & Duncan, C. P. Human discrimination learning with simultaneous and successive presentation of stimuli. *Journal of Experimental Psychology*, 1952, 44, 215-221.

It was hypothesized that the effect of opportunity to compare the positive with the negative stimuli in discrimination learning would vary with the level of difficulty of the discrimination. Two levels of discriminative difficulty were used and for each level half of a group of human subjects learned under simultaneous presentation of stimuli while the other half learned under successive presentation. It was assumed that successive presentation gave less opportunity for comparison of positive with negative stimuli. Learning was measured in terms of the number of presentations of either a pair of stimuli or a single stimulus before subject reached a criterion. The following results were obtained:

1. By either method of presenting the simuli, advanced students learned the easier discrimination more rapidly than elementary students.

2. There was no significant difference between the two methods of stimulus presentation in learning the easier discrimination.

3. Significantly poorer learning of the more difficult discrimination was obtained with successive than with simultaneous presentation of stimuli.

4. The two levels of discriminative difficulty were significantly different in trials to learn only when the successive method was used. They were not significantly different when the simultaneous method was used.

5. It was concluded that the original hypothesis--that the difficulty of the discrimination determines whether rate of discrimination learning is affected by greater opportunity to compare the stimuli--was supported.

6. The problem of comparable units of measurement in comparisons of discrimination learning under simultaneous and successive presentation was considered.

194. Lott, D., & Cronnell, B. The use of redundancy by beginning readers. Technical Report No. 13, April 3, 1969, Southwest Regional Laboratory, Inglewood, California.

Printed English is not composed of random sequences of letters. Some letters occur more often than others; some letters occur more often within the context of certain other letters. If a skilled reader is shown a sequence of letters from actual text, he can predict the next letter with far better than chance accuracy (Carson, 1961). The skilled reader's ability to make such predictions indicates that he uses the redundancy present in printed English.

A few conclusions may not be drawn about the use of redundancy by beginning readers. It is clear that knowledge and use of sequential constraints develop quite early in reading, at least where three-letter, familiar words are concerned. Children of all ages demonstrated a sophisticated knowledge of the structure of simple three-letter words. The results suggest that this knowledge increases with grade level up to about grade 4, when approximately adult sophistication is achieved. Research should now be conducted with longer sequences of letters and less familiar words to determine more precisely how knowledge and use of redundancy develop as children learn to read.

195. Maccoby, E. E. The development of stimulus selection. In Hill, J. P. (Ed.), *Minnesota Symposia on child psychology.* Minnesota: Minneapolis Unversity Press, 1969. Pp. 68-96.

There is evidence of improvement during childhood in the orientation of the sense organs toward the most informative portions of a stimulus complex. Beyond this, there is improvement in post-stimulation selective processes, and in the ability to divide attention so as to select more than one of several simultaneously available messages. A number of hypotheses have been discussed concerning the nature of the young child's deficit, and many of these explorations have yielded negative results. Although the relevant evidence has not been explicitly drawn together above, it seems that it is not especially useful to think of the deficit in terms of the child's having a more limited "information processing capacity" or "memory storage capacity" in the usual meaning of these terms. Rather, the problem would seem to be that the "capacity" the young child has is not efficiently employed. Some of the evidence has pointed to the probable importance of discrimination learning and coding or "chunking" processes, although the evidence is sparse. But the discrimination problem is of a special kind, for stimuli which the child has learned enough about so that he can readily identify them when they are presented alone become unidentifiable when they are part of a more complex multiple input. It is the effect of the unwanted material on the perception of the wanted material that is the heart of the problem. Wohlwill (1962) states the developmental principle succinctly: "the amount of irrelevant information that can be tolerated without affecting the response increases" (with age).

196. Marsh, G. Conceptual skills in beginning reading. Technical Report No. 18, July 16, 1969, Southwest Regional Laboratory, Inglewood, California.

This paper presents a task analysis of the conceptual skills prerequisite to learning to read by a phonics-based method. An attempt is made to distinguish these skills from reading's component skills.

Basic to this paper is the assumption that analysis of the prerequisite skills is a necessary preliminary to understanding the reading process. This assumption is not universally held. For example, Kolers (in press) states:

> An accurate representation...of any complex skill... cannot be performed inductively by studying the most primitive aspects of the reader's performance and working up because there is no principle to guide the induction. We will never come to understand reading if we concentrate our experimentation upon the ability to distinguish geometric forms or the ability to translate graphemes into phonemes or similar tasks.

197. Marsh, G., & Mineo, J. Children's recognition of phonemes in a word context. Technical Note No. TN-2-70-46, 1970, Southwest Regional Laboratory, Inglewood, California.

Sixty-four preschool children were trained on a task requiring them to recognize an isolated phoneme in a word context. A learning set design encompassing 192 trials over eight days was employed. Five relevant factors were investigated: a) The presence of a redundant visual cue; b) The type of phoneme (stop vs. continuant); c) The phoneme position; and d) The phonemic contrast between the positive and negative exemplars.

The redundant visual cue improved performance considerably but performance fell to control group levels in the second week when the cue was removed. Generally, continuants were superior to stops. The position and contrast factors interacted with phoneme type. Groups transferred within phoneme class were superior to those transferred between phoneme class. In the second week a number of variables interacted in a complex fashion.

198. Martin, E. Relation between stimulus recognition and paired-associate learning. *Journal of Experimental Psychology*, 1967, 74(4), 500-505.

The hypotheses tested were that association activation, as evidenced by correct responding, is contingent upon stimulus recognition but that stimulus recognition does not depend upon the existence of associated responses. The data support both hypotheses. Using the study-test method, subjects were given practice on 12 trigram-number pairs where 6 of the pairs remained intact and 6 were re-paired anew on each study trial. On each test trial, the 12 study-trials trigrams were randomly intermixed with 12 new filler trigrams. The subject had first to make a stimulus-recognition response and then to emit a number response.

199. Mayzner, M. S., & Tresselt, M. E. Individual differences in stored digram frequencies and the immediate serial recall of letter and number strings. *Psychonomic Science*, 1967, 7(10), 359.

This study examined the immediate serial recall of letter and number strings as a joint function of (a) the single-letter and sequential digram frequencies of the letter strings and (b) individual differences in the degree to which subjects already have in "store" information concerning the relative frequency of digrams as they occur in the language. The results clearly showed that high digram storage subjects show superior recall to low digram storage subjects for letter strings that vary both with respect to their single-letter frequencies and sequential digram frequencies, but that no differences in recall occur between the high and low digram storage subjects for the number strings.

200. McCutcheon, B. A., & McDowell, E. E. Intralist similarity and acquisition and generalization of word recognition. *Reading Teacher*, 1969, 23(2), 103-115.

The research results here supported the proposed hypothesis that high intralist similarity in beginning reading results in greater word recognition skills and lesser tendency to make falsely generalized responses to other words. Subjects were trained to read lists of words with high, low, and moderate similarity.

The subjects who were trained to read words of low intralist similarity did reach criterion before those who were trained to read words of high intralist similarity. Thus, the data for trials to criterion supported the hypothesis that high quality similarity impedes rate of learning. The findings for the number of errors on eighteen presentations of lists of high-, moderate-, and low-intralist-similarity words (Rate of Learning Lists Test), however, failed to support the hypothesis that increasing intralist similarity impedes the rate of learning words. More errors were made on the moderate-similarity list than on either than high- or low-intralist-similarity lists.

Because the data for trials to criterion for low similarity lists and high similarity lists strongly supported the hypothesis, it was suspected that methodological difficulties might have obscured the relationship between intralist similarity and rate of learning the lists. The writers are unable to explain why the moderate similarity list was the most difficult to learn.

The data for word recognition-generalization consistently indicated that training on lists of low similarity leads to incorrect identifications and false generalizations when new but similar words confront the beginning reader. It has been stated (Cutts, 1964) that teaching beginning reading with words chosen on the basis of their gross perceptual differences engenders a tendency to learn words on the basis of a single letter or some other readily apparent cue. The beginning reader, under such circumstances, achieves false success in that the rate of acquiring a low similarity list is faster, but the economy is lost when the child is unable either to recognize the originally learned word in a list of similar words or to identify similar words as being different.

201. Merikel, P. M. Presentation rate and order of approximation to English as determinants of short-term memory. *Canadian Journal of Psychology*, 1969, 23(2), 196-202.

Twenty-eight sequences of 10 letters representing zero-order and second-order approximations to English were presented sequentially at presentation rates of 3 letter/sec, 2 letters/sec, and 1 letter/sec. Different groups of 10 subjects received each rate of presentation. In agreement with previous studies, the increased time for input processing available at the slower presentation rates produced greater differentiation in the immediate recall of zero-order and second-order approximations. Additional analyses suggested that the increased differentiation was attributable to both a greater increase in the efficiency of processing order information and more rapid processing of individual letters in the second-order approximations.

202. Miller, G. A. The magical number 7, plus or minus 2, some limits on our capacity for processing information. *Psychological Review*, 1956, 63, 81-97.

First, the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember. By organizing the stimulus input simultaneously into several dimensions and successively into a sequence of chunks, we manage to break (or at least stretch), this information bottleneck.

Second, the process of recoding is a very important one in human psychology and deserves much more explicit attention than it has received. Recoding is less accessible to experimental manipulation than nonsense syllables or T mazes, the traditional experimental psychologist has contribued little or nothing to their analysis.

Third, the concepts and measures provided by the theory of information provide a quantitative way of getting at some of the individual difference questions of recoding processes. The theory provides us with a yardstick for calibrating our stimulus materials and for measuring the performance of our subjects. Informational concepts have already proved valuable in the study of discrimination and of language; they promise a great deal in the study of learning and memory; and it has even been proposed that they can be useful in the study of concept formation.

And finally, what about the magical number seven? What about the seven wonders of the world, the seven seas, the seven deadly sins, the seven daughters of Atlas in the Pleiades, the seven ages of man, the sevel levels of hell, the seven primary colors, the seven notes of the musical scale, and the seven days of the week? What about the seven-point rating scale, the seven categories for absolute judgment, the seven objects in the span of attention, and the seven digits in the span of immediate memory? For the present it is proposed to withhold judgment. Perhaps there is something deep and profound behind all these sevens, something just calling out for us to discover it. But it is suspected that it is only a pernicious, Pythagorean coincidence.

203. Miller, G. A. Free recall of redundant strings of letters. *Journal of Experimental Psychology*, 1958, 56(6), 485-491.

The present experiment explores the recall of redundant, as opposed to random, strings of symbols. First, an algebra for generating strings of symbols according to explict rules is defined and a set of redundant strings is generated. A subset of these strings is memorized by subject, using the method of free recall. As a control, the same procedure is used for equivalent strings generated by a table of random numbers. It is found that, although subject knows nothing of the rules of formation, the redundant strings are more easily memorized. Since the redundant strings show greater intralist similarity, it is concluded that subjects group and recode the redundant strings, thus avoiding the interference effects that would be expected for the uncoded strings.

In agreement with earlier studies, it is found that the amount of material learned increases when the strings are redundant, but the amount of information, measured in bits, decreases. In terms of the information measure, therefore, redundancy in the materials to be learned does not increas the efficiency of learning. The several parameters involved in these relations are briefly reviewed.

The results also indicate that, for the particular redundancy used, some subjects find the redundant strings more difficult to learn if they have first learned a series of random strings.

204. Miller, G. A., & Selfridge, J. A. Verbal context and the recall of meaningful material. *American Journal of Psychology*, 1950, 63, 176-185.

A quantitative definition for verbal context is given in terms of dependent probabilities. The definition is used to construct lists of words with varying degrees of contextual determination. When short range contextual dependencies are preserved in nonsense material, the nonsense is as readily recalled as is meaningful material. From this result it is argued that contextual dependencies extending over five or six words permit positive transfer, and that it is these familiar dependencies, rather than the meaning per se, that facilitate learning.

205. Mishkin, M., & Forgays, D. G. Word recognition as a function of retinal locus. *Journal of Experimental Psychology*, 1952, 43, 43-48.

Four experiments were performed to investigate the accuracy of tachistoscopic recognition of words placed in the left and right peripheral fields of vision. Two experiments demonstrated that subjects recognized significantly more words placed in certain parts of the right visual field than in corresponding parts of the left, confirming the hypothesis of a selective retinal training arising from the reading situation. Alternatives for explaining and interpreting this phenomena were investigated in the two other experiments performed in conjunction with this research.

The results support the theory that a particular perception depends on the excitation of particular nerve cells, and are inconsistent with the theory of a general equipotentiality in vision.

206. Murray, J. P., & Youniss, J. Achievement of inferential transitivity and its relation to serial ordering. *Child Development*, 1968, 38, 1259-1268.

Arguing that the standard situation for studying transitivity prompts correct but nontransitive conclusions, we compared the standard with two other situations which were more likely to require the use of a middle term. Seriation of size, presumably a prerequisite operation for transitive size relations, was also studied. Developmental differences among three age levels were observed, but not in the standard situation. In addition, subjects who showed clear understanding of transitive inference also demonstrated success on seriation. These observations support Piaget's discussion of transitivity and suggest clarification of an important methodological issue.

207. Offenbach, S. I. Studies of children's probability learning behavior: II. Effect of method and event frequency at two age levels. *Child Development*, 1965, 36, 951-962.

Kindergarten and fourth-grade children performed in a probability learning task in which the stimuli were presented either simultaneously or successively. The more frequent event occured 60 percent, 75 percent, or 90 percent of the time. "Global" and "Intratask" measures of performance were analyzed. The global measures (predictions of E_1) indicated that both age groups responded appropriately to the E_1 frequencies. Effects of the method of stimulus presentation were slight and were found only at the 75 percent E_1 level. The analyses of intratask behavior indicated that the simultaneous procedure made it easier for both age groups to respond on the basis of previous outcomes. The data also indicated that fourth-graders tried to find "rules" governing the occurrence of the events, while the younger children responded to each event in isolation.

208. Orton, S. T. Specific reading disability, strephosymbolia. *Journal of American Medical Association*, 1928, 90, 1095-1099.

Specific disability in reading, the so called congenital word blindness, can be shown to be unassociated with subnormal intelligence. There is no evidence that it is due to a local brain defect. Children with this disability have difficulty differentiating p and q and b and d, have a striking tendency to confuse palindromic words like was and saw and to reverse paired letters and symbols, show a considerable capacity for reading from a mirror and evidence facilities to produce mirror writing. The condition is believed to be a physiological variant due to the persistance of the activity of the non-dominant cerebral hemisphere and is called strephosymbolia. It forms a clear cut clinical entity which can be diagnosed by appropriate examination methods. Proper instructions, which include directional kinaesthetic training.

209. Otto, W., & Pizillo, C. Effect of intralist similarity on kindergarten pupils' rate of word acquisition and transfer. *Journal of Reading Behavior*, 1970-71, 3(1), 14-19.

Studies of kindergarten pupils have shown that while low intralist similarity results in more rapid acquisition than high intralist similarity there are also more incorrect identification and false generalizations on transfer tasks. The inference has been that if pupils were taught highly similar words they would make fewer susequent errors because they would be less prone to fixate on single features of the words. The focus has, however, been on the extremes: high versus low similarity. Data from the present study, designed to extend the earlier results through procedural changes, suggest that moderate similarity may also result in efficient learning. The main implication has to do with the pragmatic matter of preparing beginning reading materials.

210. Pufall, P. B., & Furth, H. G. Recognition and learning of visual sequences in young children. *Child Development*, 1966, 37, 827-836.

Two studies investigated recognition and learning of visual sequences in 4- to 6-year-old children. Success on these tasks implied discriminative mastery among sequences composed of identical elements but arranged in different sequential orders. Experiment I demonstrated that 4-year-old children could match sequences and that for all ages performance improved when sequences were perceptually present. Experiment II reported tasks of learning associate responses to sequences. On successively presented sequences, no children succeed at age 4, while at ages 5 and 6 most children succeeded. Errors decreased with age. On simultaneous presentation, a majority at all ages succeeded. The fact that these results occurred even through training had been given suggests that 4-year-old children are not likely to internally construct or maintain sequences without perceptual support. The results are seen as supporting Piaget's position on the development of serial ordering.

211. Reicher, G. M. Perceptual recognition as a function of meaningfulness of stimulus material. *Journal of Experimental Psychology*, 1969, 81(2), 275-280.

The present study evaluates a class of models of human information processing made popular by Broadbent. A brief tachistoscopic display of one or two single letters, four-letter common words, or four-letter nonwords was immediately followed by a masking field along with two single-letter response alternatives chosen so as to minimize informational differences among the tasks. Giving subjects response alternatives before the stimulus display as well as after it caused an impairment of performance. Performance on single words was clearly better than performance on single letters. The data suggest that the first stages of information processing are done in parallel, but scanning of the resultant highly processed information is done serially.

212. Robinson, J. P. Effects of verbal and imaginal learning on recognition, free recall, and aided recall tests. *Journal of Experimental Psychology*, 1970, 86(1), 115-117.

In two experiments, subjects were instructed to learn line drawings either by naming each one or by encoding an image of it, and were then given one of three kinds of retention tests. Namers consistently performed better than Imaginers. Postexperimental reports indicated that at the time of the retention tests, Namers could remember names for more stimuli than Imaginers, so the learning instructions appeared to have their intended effect. Both Namers and Imaginers performed better on stimuli, whose names they remembered than on other stimuli. In one of the experiments, Namers performed better than Imaginers on stimuli whose names were not remembered, suggesting that even unsuccessful attempts to remember names for stimuli can facilitate retention of the stimuli.

213. Ross, D. Retention and transfer of mediation set in paired-associate learning of educable retarded children. *Journal of Educational Psychology*, 1971, 62(4), 322-327.

Measures of ability to learn paired associates and to use mediational links were obtained on young educable mentally retarded subjects in a laboratory setting. The experimental group subjects (n = 19) were given long-term mediation training within the context of a special music program which emphasized the principle and utility of mediational links. The control group subjects (n = 19) participated in a traditional primary music program. Postexperimental measures showed retention and transfer of the mediation training by the experimental group with marked improvement in their nonverbal ($p < .001$) and verbal ($p < .0005$) paired-associate performance.

214. Samuels, S. J. Attentional processes in reading: The effect of pictures on the acquisition of reading responses. *Journal of Educational Psychology*, 1967, 58, 337-343.

Pictures may be used as prompts when the reader cannot read a word in the text, but pictures may miscue and may divert attention from printed words. In Experiment I, 30 randomly assigned pre-1st graders learned to read 4 words with no pictures, a simple picture, or a complex picture present. During acquisition trials, when pictures were present, the simple and complex picture groups made more correct responses ($p < .01$). During test trials, with no pictures present, the no-picture group excelled ($p < .01$). In Experiment II, 26 matched pairs of 1st graders were given classroom reading instruction under a no-picture or picture condition. The results disclosed that poor readers with no picture present learned more words ($p < .01$). Among better readers the difference was not significant. The results are discussed in terms of attentional processes.

215. Samuels, S. J. Effect of word associations on reading speed, recall, and guessing behavior on tests. *Journal of Educational Psychology*, 1968, 59(1), 12-15.

A paragraph containing words with high-associative (HA) relationships should be read faster and with better recall than a similar paragraph containing words with low-associative (LA) relationships. Mean reading time for elementary school subjects in the HA condition was 43.82 sec. and 58.81 sec. in the LA condition ($p < .05$). The mean number of questions answered correctly for HA was 9.50 and 5.04 for LA ($p < .001$). When college subjects read the same paragraphs, the mean time was 35.26 sec. for HA and 38.26 for LA ($p < .01$). The mean number of questions answered correctly was 9.69 for HA and 6.87 for LA ($p < .001$). When required to guess the correct answer, control subjects chose significantly more often alternatives which contained words having HA relationships with words in the stem of the question. Results on reading speed are discussed in terms of the effect of word associations on perceptual factors in word recognition.

216. Samuels, S. J. Effect of simultaneous versus successive discrimination training on paired-associate learning. *Journal of Educational Psychology*, 1969, 60, 46-48.

Sixty kindergarteners were randomly assigned to a simultaneous or successive discrimination group. During discrimination training subjects had to indicate which alternative matched one of several letters. The stimuli were presented either simultaneously (a letter and response alternatives presented together) or successively (a letter presented by itself, then response alternatives presented by themselves). Following criterion, both groups were given the same paired-associate learning task in which they had to associate names with the letters of the prior discrimination task. On the discrimination task the simultaneous group required fewer trials to reach criterion, but on the transfer task the successive discrimination group required fewer trials. Results are discussed in terms of stimulus similarity.

217. Scandura, J. M., & Voorhies, D. J. Effect of irrelevant attributes and irrelevant operations on rule learning. *Journal of Educational Psychology*, 1971, 62(4), 352-356.

The negative effect of irrelevant attributes on concept learning has been well documented. Rule learning, however, involves both attributes and operations. The purpose of this study was to investigate the effects of both kinds of irrelevancies in rule learning. A 3 X 3 factorial design was employed, with the number of irrelevant attributes (0, 1, 2) and the number of irrelevant operations (0, 1, 2) being the factors. Both factors delayed rule learning. The results were compatible with the notion that subjects select from among the available attributes and operations, testing the various combinations in quasi-systematic fashion, until a rule is found which satisfies all instances.

218. Shuell, T. J., & Keppel, G. Learning ability and retention. *Journal of Educational Psychology*, 1970, 61(1), 59-65.

While there are obvious individual differences in learning ability, it does not necessarily follow that similar differences are present in memory. Three experiments concerned with determining the extent to which individuals differ in their ability to remember after they have been equated for degree of original learning are reported in the present paper. Learning ability is defined in terms of performance on a free-recall test. Experiment I investigates free-recall performance for "fast" and "slow" learners at various presentation rates. The results of this experiment indicate that fast and slow learners profit from additional study time to about the same extent and that the performance of the two groups are equivalent when the stimulus list is presented at a 1- and a 5-second rate, respectively. These two rates are used in Experiments II and III to equate performance of fast and slow learners prior to the onset of 24- and 48-hour retention intervals. The results indicate that individual differences in long-term retention are at best minimal when subjects are equated for degree of original learning.

219. Spear, P. S. Motivational effects of praise and criticism on children's learning. *Developmental Psychology*, 1970, 3(1), 124-132.

Sixty first-grade and sixty fifth-grade boys learned either an easy or difficult two-choice simultaneous discrimination task, consisting of 10 pairs, under one of four reinforcement conditions (praise, criticism, irrelevant comments, and silence). Two female adult experimenters, each testing 30 subjects at each age level, administered social reinforcement during the first three trials. Knowledge of results was provided independently after each response. Results suggested approval and disapproval affect the subject's motivational level (measured by rate of responding) rather than learning (assessed by acquisition measures). Response rates of younger boys were more affected by approval and disapproval than those of older boys. Younger subjects receiving criticism were consistently slower in responding than subjects receiving praise or control.

220. Stollnitz, F. Spatial variables, observing responses, and discrimination learning sets. *Psychological Review,* 1965, 72(4), 247-261.

An observing response is any response that results in exposure to a discriminative stimulus. Two assumptions are made: that the probability of occurrence of an observing response varies (a) directly with cue area, and (b) inversely with spatial separation between cue and response. With these assumptions, observing-response theory explains the effects of these two spatial variables on discrimination learning by monkeys, chimpanzees, and children. Prolonged training on a single discrimination problem can overcome the difficulty produced by these variables, but, surprisingly, the difficulty persists through extensive learning-set training. It is concluded that changing problems every few trials in learning-set training results in extinction of any observing response that might be reinforced within problems.

221. Trabasso, T., & Bower, G. H. *Attention in learning: Theory and research.* New York: John Wiley & Sons, 1968. Summary of Chapter 6, Cue salience and what is learned.

The experiments in this chapter tested predictions regarding solution types as the salience of the two redundant and relevant cues varied. The expectation was that an increase in the number of irrelevant cues would lower the saliences of the relevant cues and thus reduce both the learning rate and the frequency of two-cue solutions. These outcomes were obtained in both experiments, and the effects were stronger with the letter than with the geometric stimuli. In the first experiment, it was expected that an increase in the salience or discriminability of one relevant dimension (size) would increase both the learning rate and frequency of subjects who learn this dimension. The effect on learning rate was small and insignificant, but the effect on solution type was substantial and in the expected direction. In the second experiment, the salience of a letter was increased by an emphasizer (a red underline); some adult subjects had only one letter emphasized whereas others experienced an alternating emphasis on each relevant letter. The expectations were that these groups would learn faster than the unemphasized control group, that the subjects with single-letter emphasis would mainly learn only this cue and that the alternating emphasis would increase the likelihood of a two-cue solution. This pattern of results was obtained. In single-cue emphasis condition, 95% of the subjects learned the emphasized cue while 20% learned the unemphasized cue (counting two-cue solvers in both percentages). The shifting emphasizer increased the relative frequency of two-cue solutions from the control level of 7% to 65%. In qualtative terms, these results confirm the general type of theory proposed.

222. Tulving, E., & Pearlstone, Z. Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior*, 1966, 5, 381-391.

The subjects learned, on a single trial, lists of words belonging to explicitly designated conceptual categories. Lists varied in terms of length (12, 24, and 48 words) and number of words per category (1, 2, and 4). Immediate recall was tested either in presence or absence of category names as retrieval cues. Cued recall was higher than noncued recall, the difference varying directly with lists length and inversely with number of items per category. This finding was interpreted as indicating that sufficiently intact memory traces of many words not recalled under the noncued recall conditions were available in the memory storage, but not accessible for retrieval. Further analysis of the data in terms of recall of categories and recall of words within recalled categories suggested two independent retrieval processes, one concerned with the accessibility of higher-order memory units, the other with accessibility of items within higher-order units.

223. Underwood, B. J., Rundquist, W. N., & Schultz, R. H. Response learning of paired associate lists as a function of intralist similarity. *Journal of Experimental Psychology*, 1959, 58, 70-78.

Verbal learning may be conceptualized as a two-stage process. In the first phase subject must learn the responses, in the second he must attach them to specific stimuli. The present experiments dealt directly with the first stage only. It was hypothesized that: (a) response learning is initially more rapid the higher the response similarity in a paired-associate list; and (b) teaching subject the responses before he learns a paired-associate list would initially facilitate the learning of this list.

Two paired-associate lists were used. In one set of conditions (control), subjects merely learned the paired-associate lists by standard procedures for 15 trials. In a second set of conditions, subjects were taught the responses prior to learning the paired-associate list for 15 trials. In the third set of conditions standard paired-associate learning was used but different groups of subjects were stopped after various trials and were asked to write down all the responses they could remember. These three sets of conditions required 16 groups of subjects. There were 20 in each group, all naive to verbal learning experiments.

The results show that:

(a) Teaching subject the responses prior to paired-assoicate learning factilitates the learning of lists with both high and low similarity among the responses.

(b) In response learning (prior to paired-associate learning) items with high similarity are learned initially more rapidly than are items of low similarity, although for both lists learning was very rapid.

The results confirm the expectation that high intralist response similarity would facilitate response learning. Thus, the results are consistent with the two-stage conception of learning. Furthermore, the present results aid in understanding certain previous findings on the roles of stimulus similarity and response similarity in verbal learning.

224. Underwood, B. J., & Schultz, R. W. *Meaningfulness and verbal learning.* Philadelphia: J. B. Lippincott, Co., 1960. Summary of Chapters 7 and 8, Intial experiments on response frequency and Further experiments on response frequency.

The experiments in this chapter represented further tests of the frequency hypothesis. In all experiments the frequency of units in the response position of paired-associate lists was varied. The differential frequency of these units was varied in terms of the frequency with which they occur in printed text. Our critical conclusions are:

1. When single letters are learned as responses in paired-associate lists, the relationship between frequency and rate of learning is substantial, and this fact conforms to expectations of the frequency theory.

2. As the number of letters in a response increases, the relationship between frequency and learning decreases; with three-letter responses the relationship is essentially zero. No manner of slicing the data could avoid this conclusion.

3. The above facts indicate that for multiple-letter responses the frequency theory is inadequate. A reassessment of the facts that led to the theory, viewed in conjunction with the results of the experiments led to the conclusion that M (defined as association value) is not related to response learning. Some evidence was mastered in support of this contention (see also a recent study by CiMaschio, 1959).

4. The one predictor of learning which held up throughout the several experiments was the pronunciability of the verbal units; more and more pronunciability seems to point to a very fundamental attribute of verbal material.

225. Van Horn, K. R. Classification and serial processing skills in kindergarten children. Technical Memorandum No. TM-2-70-18, 1970, Southwest Regional Laboratory, Inglewood, California.

Two experiments were conducted in order to assess kindergarten children's ability to match, construct, and recall stimulus sequences and to perform multiple class membership, multiple classification, seriation, and ordination tasks. No errors were made on either experiment on the task requiring construction of sequential patterns. Error rates on the other serial processing tasks ranged from 13 to 80%. Performance on the classification tasks was even poorer with 58-93% errors. Sixty-four percent of the subjects failed the seriation task, and 54% failed the ordination task.

226. Wallach, M. A. Perceptual recognition of approximations to English in relation to spelling achievement. *Journal of Educational Psychology*, 1963, 54, 57-62.

In an experiment with 55 5th-grade children, ease of perceptual recognition was determined for nonsense words which resemble English and for nonsense words which do not. With all children being equated in recognition accuracy for the latter words, good spellers were found to recognize the former words much more readily than poor spellers. These and further results permitted the conclusion that good spellers show much greater transfer of training than poor spellers--whether the basis for this transfer rests on the learning of the sequential probability structure of letters, on phonetic generalization, or on both.

227. Ward, W. C., & Legant, P. Naming and memory in nursery school children in the absence of rehearsal. *Developmental Psychology*, 1971, 5(1), 174-175.

In Study 1, pictures of five animals and five fruits were used. Two of these were "targets" on each of the 8 trials, and were to be recognized in a 2 X 5 array. In Study 2, pictures of 20 objects were used; subsets of 9 of these constituted the 3 X 3 recognition arrays for each of the 10 trials, and two target pictures were presented per trial. In Study 3, nine pictures from Study 2 were chosen for each odd numbered trial, while a single set of nine solid color patches was used on even numbered trials; the test array was 3 X 3. There were two target stimuli on each of the first 6 trials, and three of each of the remaining 6 trials. Frequencies of use of a given stimulus as a target, and of a given position in the array as correct, were equated as nearly as possible in each study. All stimuli were familiar to most subjects; data from one child in Study 3 who had difficulty naming the colors at the conclusion of the experiment were discarded.

The error scores are presented in Table 1. No sex differences were found. In each study subjects who named the stimuli made fewer errors than those who did not; by U test, $p < .02$, $< .10$, $< .10$, respectively, yielding a combined probability level of .002 (all two-tailed tests).

Naming without rehearsing did facilitate memory for stimuli presented more than a few seconds before the test. The discrepancy from Kingsley and Hagen's (1969) results might be due to the use of a recognition test or to the more advantaged samples. The effect was found over several types of familiar stimuli, and it held whether the child had to label each picture without help or whether he only repeated a label provided by the tester. Processes in addition to rehearsal and Kingsley and Hagen's recency effect must be considered in attempting to account for labeling effects in memory.

228. Weist, R. M. Optimal versus nonoptimal conditions for retrieval. *Journal of Verbal Learning and Verbal Behavior*, 1970, 9, 311-316.

In two multitrial free-recall experiments and one multitrial cued-recall experiment with categorized word lists, the recall and relative clustering performance was found to very with list structure. In the free-recall experiments, organization and recall of a list with 4 categories and 6 items per category were found to be superior to the performance on lists having either 2 categories with 12 items per category or 12 categories with 2 items per category. When free recall was preceded by sorting words into categories, the level of performance increased in all list conditions. The recall of lists having 12 categories with 2 items per category was greatly facilitated by cuing recall. The results were interpreted as supporting the view that a limited capacity retrieval system is bounded by the number of words within a subjective unit as well as the number of subjective units.

229. Wheeler, D. D. Processes in word recognition. *Cognitive Psychology*, 1970, 1, 59-85.

Five hypotheses were proposed and tested to account for Reicher's (1968) finding that recognition of letters is more accurate in the context of a meaningful word than alone, even with redundancy controlled by a forced-choice design. All five hypotheses were rejected on the basis of the experimental results. Performance on the forced-choice letter detection task averaged

10% better when the stimuli were four-letter English words than when the stimuli were single letters appearing alone in the visual field.

Three classes of models were proposed to account for the experimental results. All three are based on analysis of the task in terms of the extraction of features from the stimuli.

230. Williams, J. P. Successive versus concurrent presentation of multiple grapheme-phoneme correspondences. *Journal of Educational Psychology*, 1968, 59(5), 309-314.

Many new instructional programs recommend that the beginning reader be given material built on a simplified, regularized pattern of 1:1 grapheme-phoneme correspondences. To test this assumption, 2 methods of training multiple correspondences (1 grapheme mapping to 2 phonemes) were compared in a paired-associate paradigm. In successive training, only 1 of the 2 phonemes associated with a particular grapheme was presented at a time, while in concurrent training, both phonemes associated with each grapheme were introduced and practiced concurrently. Results suggest that concurrent training is superior, both in terms of the kind of "set" developed and of the performance level on the correspondences given in training. These findings run counter to the typical recommendations.

231. Williams, J. P., & Ackerman, M. D. Simultaneous and successive discrimination of similar letters. *Journal of Educational Psychology*, 1971, 62(2), 132-137.

The first experiment involved 40 first-grade children in a comparison of simultaneous and successive discrimination tasks under varying degrees of stimulus similarity, that is, b versus d, or s versus b. In the second experiment, using 48 first graders, simultaneous and successive presentation of highly similar letters (b and d) were compared in a paired-associate paradigm that simulated the early reading task. Results indicated that first graders learn to discriminate and to respond to very similar letters that are reversals of one another more easily when the letters are presented successively. Suggestions for the development of training programs in early reading are made.

232. Willmon, B. Parent participation as a factor in the effectiveness of Head Start programs. *Journal of Educational Research,* 1969, 62(9), 406-410.

An investigation of the effects of parental participation in a Head Start program on the academic achievement of students as measured by the Metropolitan Reading Readiness Test. Subjects involved were 485 Negro children and fifty-six white children of similar mental ability and socio-economic background living in the Tallahassee, Florida area. Subjects were divided into three groups according to parental participation and involvement in the program.

The mean reading readiness score of the active parental participation group was higher than that of the no parental participation group ($p > .05$). The mean reading readiness score of the highly active group was higher than that of the no parental participation group ($p > .01$). Findings indicate that for this population the influence of highly active parental involvement in Head Start appeared to serve as an intervening variable which influenced academic motivation.

233. Zeaman, D., & House, B. J. The role of attention in retardate discrimination learning. In Ellis, N. R. (Ed.), *Handbook of mental deficiency.* New York: McGraw-Hill, 1963.

Retardates have been found particulary slow in forming some simple visual habits, even slower than would be expected from their low mental age (Stevenson & Iscoe, 1955; House & Zeaman, 1958a; House & Zeaman, 1960a; Girardeau, 1959). The reasons for the learning deficit do not seem to lie in the area of instrumental learning, but rather in that of *attention.* In support of this notion, data from a series of experiments with moderately retarded, trainable children have been collated here and organized by a theory of attention.